Supply Response of Cocoa in Papua New Guinea

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Abstract

Both quantitative and qualitative analyses were done to study the impact of international price movements and other variables on the production and supply of cocoa. An Error Correction Mechanism (ECM) model confirmed the cross sectional data study for the cocoa industry that cocoa production and supply in both the short and long-run does not respond to international price movements but to other non-price variables that cannot be quantified due to lack of consistent time series data. Overall, supply response to changes in international prices is inelastic in the cocoa industry. Both the long and short-run estimates are consistent with the survey results. Price factors aren't influential in the production and supply of cocoa exports. In Papua New Guinea, non-price factors are pivotal in the determination of cocoa production and export supplies. Weather also plays an important role in determining production and supply of cocoa exports in PNG in the short-run. Results were also confirmed by growers during the field survey. It was found in the survey that price of cocoa is not the only factor that affects the production, other non-economic and economic factors are also responsible.

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1.0 Introduction

Cocoa production is a major source of employment and income for growers, buyers and exporters, contributing immensely to foreign exchange earnings of Papua New Guinea (PNG). The aim of this paper is to establish the effect of changes in the international price movements of cocoa to production and supply of cocoa exports. In this study on cocoa, both quantitative and qualitative analyses were done to examine the impact of international price movements and other variables on the supply and production of cocoa in PNG. Furthermore, the paper will also try to highlight other non-price factors that affect cocoa production and export supply in PNG.

The Bank of PNG conducted field surveys to establish the factors that determine the production and export supply of cocoa, including movements in international price of cocoa. The survey found that there were a number of other independent factors (economic and non-economic) that influence the producers' decision to produce and supply cocoa. This analysis is based on interviews with company executives, extension officers, Cocoa and Coconut Research Institute (CCRI), Cocoa Board, Cooperative Societies and smallholders during the field visits to most of the cocoa-producing provinces, including Autonomous Region of Bougainville (ARB), East New Britain (ENB), Madang and East Sepik Provinces.

Ninety (90) percent of cocoa production and supply in PNG is by smallholders and 10 percent by plantations. Based on a cross section data study on smallholder, cooperative societies and plantations in major cocoa producing provinces, results show that, apart from international price movements, a wide variety of factors influence cocoa production and export supply in PNG. It was found that the need for revenue to meet community obligations, condition of infrastructures like roads and bridges, labour, land, state of technology, age and stock of cocoa trees, etc. do affect cocoa production and export supply. Also the farming methods within which agricultural production decisions are made in PNG is likely to differ from those in other countries. In addition, the various methods of farming may have changed over time as a result of changes in technology and resource constraints. An Error Correction Mechanism (ECM) model confirmed the cross sectional data study for the cocoa industry, with cocoa production and supply in both the short and long-run not responding to international price movements but to other non-price variables that cannot be quantified.

There is substantial literature on supply response of agricultural commodities but little of this is directly relevant to PNG's export commodities. Country specific data on supply elasticities are needed to ensure analysis based on such parameters will be of relevance (Hone, Haszler and Natasiwai, 2008). A number of studies have been done on cocoa production in PNG on all producer levels, including various publications by Cocoa Board, Cocoa and Coconut Research Institute (CCRI). However, there is only a few known publication on 'Supply Response of Cocoa", i.e. by Ruhle and Fleming (1999) *on Cocoa Supply Responsiveness to price and exchange rate in Papua New Guinea: Tree crop policy options project in Papua New Guinea.* They use cocoa prices, exchange rate and the price of fruits and vegetables as the main economic variables to determine supply response in PNG. In their study, two econometric models were

employed to analyze smallholder cocoa supply response. The first model looked at a separate cocoa export price and exchange rate variable, while the second looked at a single cocoa producer price variable. However, in this study, it was also found that there are other independent non-economic variables that affect the production and supply of cocoa in PNG.

This paper is organized as follows; the first section discusses the economics of cocoa production and supply in PNG, a descriptive overview of the cocoa production and export supply, with trend in price developments. The second section looks at the survey results and discussions, dissecting the factors that affect cocoa production and supply in PNG, followed by a section on the major constraints that challenge the productive capacity of the cocoa industry. Time series data is not available for all the variables discussed as major determinants of cocoa production and supply, so the next section will use those variables that have available time series data to develop a model for the cocoa industry supply response function. This will be followed by conclusion, recommendations and highlight areas of future research.

2. 0 Economics of Cocoa Production and Supply in PNG

Theobroma cacao, commonly known as cocoa is believed to have been brought to PNG in the 19th Century by the Germans, which made PNG one of the cocoa producing nations. PNG has the ideal warm and humid climate, temperature, and frequent rainfalls for cocoa to grow and produce some of the most fine-flavored cocoa in the world. Since its introduction, it has gradually become one of PNG's major export commodities, following coffee and palm oil, bringing in revenue and much needed foreign exchange for the government, employment and income for producers. The cocoa producers are rural households, mainly in East and West New Britain, Autonomous Region of Bougainville (ARB), New Ireland, Madang, East and West Sepik Provinces, Oro and Morobe, and potential for production in Gulf, Central, Milne Bay, Oro, Morobe, Sandaun, Manus and Simbu provinces. Cocoa played significant roles in changing the life styles of many Papua New Guineans who participate in the production of cocoa. The willingness and commitment of the producers, with assistance from the Cocoa Board, through extension services, and the research and development undertaken by various organizations, including CCRI and businesses in the industry has assisted the development of the cocoa industry.

Prior to 1978, plantations (or estates) were dominant in total cocoa production but up until recent years, the composition reversed whereby production by the smallholders is far greater than the plantations. The significant increase reflects the increasing number of smallholders. Curry et al. (2007) found that the majority of PNG's cocoa is produced by more than 150,000 families, each farming less than 5 hectares of land, and producing an annual average yield of 300-400kg of dry beans per hectare. These yields are typical of smallholder production, which reflects inadequate management inputs and losses due to the black pod and canker diseases (Guest 2007; Keane and Prior 1991; McMahon and Purwantara 2004; Saul 1989), including the pod borer

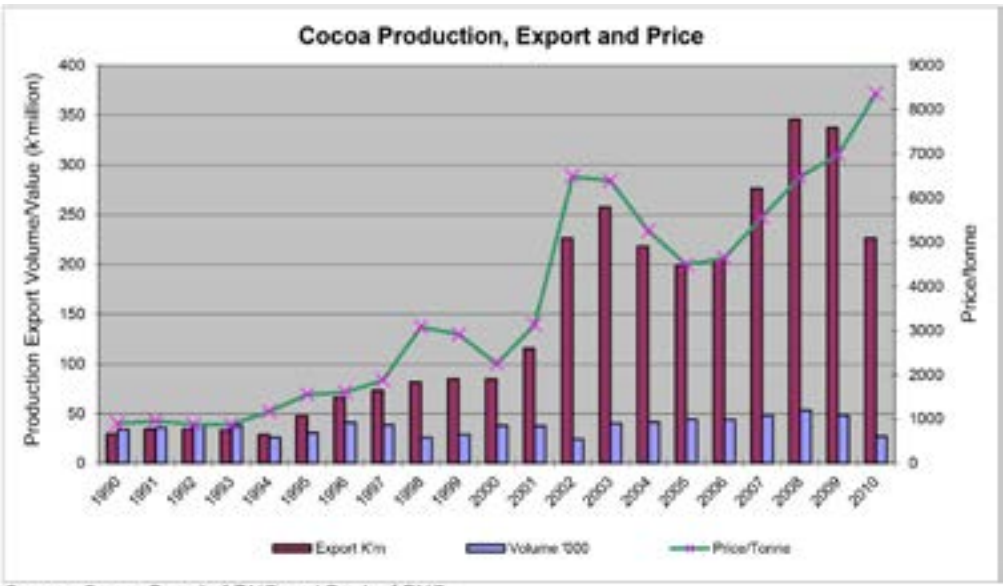
disease.

Cocoa was the second most valuable export crop in PNG until 1990 when it was surpassed by palm oil. The industry has grown slowly over the years and has become a major export revenue earner for the economy and sustains the livelihoods of rural smallholders directly engaged in cocoa production and the plantation labourers. Overall cocoa production in PNG peaked at 50,000 tonnes in 2005/06, and has since fluctuated between this amount and around 40,000 tonnes per annum thereafter. The decline in production has been a concern to the industry so the Cocoa Board, with the assistance of the European Union (EU) and other international organisations, attempted to identify and recommend measures to address the declining productivity and other aspects including the quality of cocoa. The attack by the cocoa pod borer has affected cocoa production, with production being reduced to record low levels.

According to Curry et al (2007), most farm management recommendations were developed for well-managed plantations. As plantations no longer dominate the cocoa industry such farm management skills are no longer being used (Connell, 1997). When the plantation sector was the dominant player in the industry in PNG, control of diseases was based on high-input cultural practices, fungicides and disease resistant clones (Prior 1984). Connell (1997) established that a fall in the international cocoa price in the late 1980s resulted in the decline in the plantation sector and a reduction in inputs, such as fertilizer and fungicides. Smallholder cocoa plantings increased after 1965 and by the mid-1980s contributed approximately 70% of PNG's total cocoa production. This further increased to 88% in 2007. Curry et al. (2007) and Prior (1984) found that while plantations operated under more intensive input conditions with different labour sources, smallholders rely on family labour, applying minimal chemical inputs and tend to reduce spending on inputs when cocoa price falls. Furthermore, the decline in plantation sector production is the result of many former plantations being returned to traditional landowners.

Smallholder production as a percentage of the total production increased from around 31 percent in 1970 to 93 percent in 2009, while production by plantations fell from 69 percent to almost 7 percent during the same period. The decline in plantation production is attributed to five (5) main reasons as outlined in a study by Curry, Lummani and Omuru (2010). These being; (1) the plantation land acquisition scheme initiated by the national government in 1978; (2) high costs of production coupled with low commodity prices, especially from the 1980s onwards; (3) lack of land for further expansion; (4) agro-climatic factors; and (5) the lack of capital and managerial skills.

Chart 1: Cocoa Production, Export Volume, Value in K' million and Prices per tonne

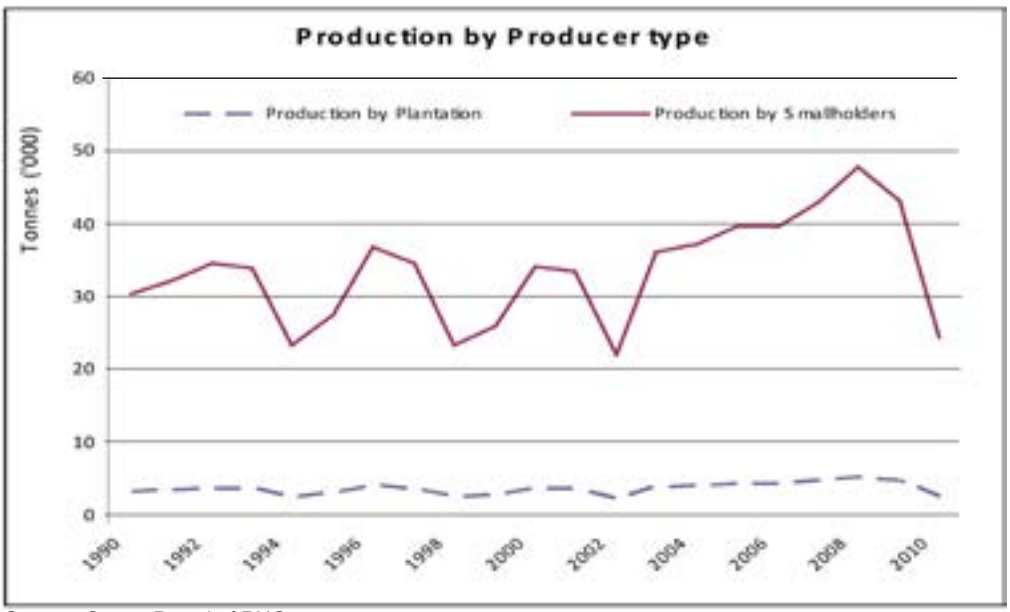


Source: Cocoa Board of PNG and Bank of PNG

Smallholder cocoa farmers form associations or co-operative societies, through which to access help from the Government via the Cocoa Board. Most of the cocoa producing provinces have well established network of cocoa cooperative societies, through which the Cocoa Board regional office implement its extension services. The extension service is also a source of effective networking where the smallholders share knowledge, voice their concerns on factors that affect the farmers, access vital information like prices, and help each other on issues and challenges that confront them and the industry. Involving local communities/stakeholders in the production process is one way of maintaining consistency in the level of production. Production from smallholders fluctuates over time, mostly depending on their capacity and their revenue requirements.

Regardless of fluctuations in the international prices of cocoa and its associated products, production volume has increased steadily. Based on data obtained by the Bank of Papua New Guinea (BPNG) from the Cocoa Board of PNG in 2010, 41,300 tonnes of cocoa was exported, accounting for 6.3 percent of the total agricultural exports by PNG. The revenue from cocoa exports in 2010 was K347.6 million, which is 16.6% of the total export earnings from agricultural exports (BPNG, June 2011 Quarterly Economic Bulletin).

Chart 2: Production by Producer type



Source: Cocoa Board of PNG

Production of cocoa by smallholder farmers is mainly driven by the demand for revenue to sustain daily livelihood, settlement of school fees, savings and reinvestment, and other community and customary obligations such as contribution to bride price payment, death, compensation, etc. The need for revenue compels people to work in their cocoa plots to increase production or seek alternative and or complementary income-generating activity, like producing garden food, coconut/copra and betelnut. These behavioral patterns of the farmers can be reasoned with, because unlike the plantations, smallholders have no contractual obligations, but driven by need basis and any surplus income is either saved or reinvested in the cocoa blocks. These factors influence the smallholders' motivation to increase/decrease production, regardless of the change in the price of cocoa, including fluctuations in the kina exchange rates. Also the fluctuating nature of the price of cocoa enable the smallholders to balance out their income by switching to alternative crops, like copra, betelnut and other food crops that they produce. They also have the option of selling trade store goods or even take care of livestock to sustain their income. The transmission of higher international price and a depreciating kina exchange rate to the smallholder producers is said to be delayed and distorted along the way by middleman, which dissuade smallholder growers from increasing their production.

The plantation sector produces cocoa for commercial purpose to maximize profit and add value to their shareholders. The plantation sector also provides employment; income and foreign exchange for PNG. The challenges such as the pod borer disease,

deteriorating conditions of basic infrastructures like roads and bridges are problems that affect both smallholder producers and the plantations.

3.0 Survey Description

The Bank of PNG conducted field surveys in major cocoa-producing provinces in ENB, Madang, ARB, New Ireland and East Sepik in 2009 and 2010 to collect data on the production of cocoa by smallholders, cooperative societies and plantations in the country. The aim of the survey was to collect the producers' views on the factors that affect their decisions on how much and why they produce cocoa, apart from changes in price. The project team visited smallholders, block-holders and some plantations to collect cross-sectional data, including the reasons that drive producers to produce cocoa.

3.1 Survey Results and Discussions

The following analysis are based on the interviews carried out with various key stakeholders in the cocoa industry, including the Cocoa Board, CCRI, plantation, smallholder producers, and cooperative societies across the major cocoa-producing provinces. The survey results depict typical smallholder behavior in the cocoa industry. During times of low prices or high price of alternative cash crops, the farmer opts to produce those commodities rather than cocoa or occasionally farmers can concurrently produce alternative cash crops, including garden produce and further involve in other commercial activities, such as raising livestock, selling store good or even running a PMV. The results also show problems faced by the producers, which vary in each location, affecting the production and movement of cocoa to the nearest buying point. For example, the cocoa bod borer problems faced by a producer in ENB are not the same as the problems of roads and bridges faced by a producer in Madang or East Sepik provinces.

With the smallholder producers, they formed corporative societies to enhance their production capacity by assisting each other. There are on average 140 members in each cooperative society (16 families with 10 members in each family). The average production per family per hectare per year is 300-500 kg. With a total land area of around 175 hectares, they are able to produce on average 5-10 tonnes every year, with greater untapped potential to increase the production level up to 15 tonnes, with sufficient reserve land and adequate financial and administrative support.

Smallholder cocoa farmers - members of two Cooperative Societies in Madang (Bargram and Mesam) listening attentively to a Bank of PNG officer carrying out awareness during the survey. Photos: Aba and Aipi (2010).

Initial analysis of the cocoa industry show that only 22 percent of variations in export volume are caused by movements in international prices of Cocoa. This implies that 78 percent of the variation is caused by other independent factors. This survey aims to identify these factors and whether the producers respond to changes in international prices and fluctuations in kina exchange rates. Production of cocoa in PNG is sensitive to movements in the prices of cocoa. It was shown by (Ruhle and Fleming (1999)) that changes, whether an increase or a decrease in the price of cocoa tend to have a positive correlation with the production and supply of cocoa. External price shocks can drastically affect production of cocoa in PNG. Does this finding by Ruhle and Fleming still hold for PNG today? The aim of this paper is to establish that linkage if there is any, and how much volume changes in response to price movements.

Some studies have been done on improving productivity of the smallholder cocoa farmers and the supply response to price and exchange rate movements in PNG. As these studies pointed out, there are a number of independent factors that determine the productivity levels and responsiveness in the smallholder sector. An increase in the price of cocoa and a weaker kina exchange rate are regarded by the producers as two factors that lead to increased production in the long term, though there is a lag in the transmission of the change in the price and kina exchange rate. There are delays in transmission of higher prices and exchange rate depreciation to the smallholders and the transmission is distorted along the way as reported by most of the smallholder cocoa producer respondents. If the production and supply of cocoa is inelastic (insensitive) to changes in the international price, this could imply that other independent factors are responsible for a consistent degree of production and supply of cocoa.

3.2 What determines Cocoa Production and Supply?

The survey highlighted the key driving forces that affect production and found that cocoa is produced in PNG for varying reasons, including income and status. The objective of the cocoa producer plays an important role in determining what to produce, why they do so and how much to produce. The smallholder cocoa farmers, who produce around 90 percent of total production, produce cocoa to earn income, reputation and sustain their livelihood, while the plantations' produce cocoa for commercial purposes, profit maximization, and adding value to the shareholders. The smallholder cocoa producer may aim either at maximising money income from the sale of cocoa, or maximising non-monetary income such as earning goodwill or building-up his/her reputation as a producer in the society. Both of these two objectives are more common in the cocoa growing segments in PNG.

As a cash crop, cocoa is grown by most households in the cocoa growing provinces, and forms an important basis for direct employment in the formal and informal sectors, and regular income for the families involved, including the plantations. Returns to labour and capital investment are important factors that influence the production of commodities for sale in PNG, including cocoa. That is, how much a person can earn with his/her input of labour, tools, equipment and machines, determines how much cocoa a farmer can produce. Also the demand for revenue to meet certain obligations like school fees, bride price payment, compensation, improving living standards, improving people's wealth and participation in customs and traditions, etc. forces people to work on their cocoa plots to earn the income they need to meet these obligations. Cocoa generates a reasonable amount of income for the producers. However, price incentives, access to more land, credit and appropriate inputs, public investments in road and transport systems, extension services, and minimizing the impact of the cocoa pod borer disease are some of the key factors that challenge improvements in production level of cocoa. Most of them are virtually lacking in almost all the cocoa growing regions renowned for the producing quality cocoa.

In the survey, it was found that the following factors affect the farmers' decisions on how much, when and why they produce cocoa. These variables include: price of cocoa; prices of other commodities; cultivation of other crops; state of technology used; labour input and return on labour; number of producers; management skills and time management; customs/traditions; inputs and prices of inputs; land accessibility; cocoa tree stock and age; cocoa seasons; the level of assistance and weather conditions.

3.2.1 Prices of cocoa

It is assumed that the price of cocoa determines how much cocoa a producer produces in Papua New Guinea. The price of cocoa is determined by international market fundamentals of supply and demand. International cocoa prices are determined by production levels of some of the major cocoa producers in the world, such as Ivory Coast. There is an inverse relationship between world cocoa supply and international

price of cocoa. When world cocoa supply increases, international price of cocoa declines, and the vice versa happens when world cocoa supply decreases. Papua New Guinea is a minor player in the world cocoa market; as a result PNG is a price taker, affected regularly by volatilities in the international cocoa market developments.

Does the price of cocoa affect the amount of cocoa produced in PNG? Studies by Ruhle and Fleming (1999) using a static Nerlovian partial adjustment model shows that supply of cocoa especially by smallholders has an elasticity of 0.23, which means that a kina change (increase or decrease) in the price of cocoa will result in a 0.23 percent change (increase or decrease) in the supply of cocoa. Aside from other factors, the price of cocoa tends to have a positive relationship with supply. This was confirmed by the survey carried out by the Bank of PNG that producers respond positively to changes in price of cocoa. Almost 100 percent of the producers interviewed indicated that changes in cocoa price affect their decisions to produce cocoa, that is, the quantity supplied increases as price increases and decreases as price decreases.

Displayed cocoa price at Agmark buying point, Tokiala, East New Britain. A scale used for weighing cocoa beans and dried cocoa beans in the background. Photos: Aba, Aipi and Kauzi (2010).

The interaction of the forces of supply and demand at the international market, exchange rate fluctuations and levies or bounties imposed by Cocoa Board, determines the final price of a smallholder cocoa producer in PNG. The final price determines the smallholder's production decisions in PNG. Survey results show that a decline in cocoa price serves as major disincentive for producers, consequently they have the alternative to switch to producing other cash commodities like copra, betelnut, or be involved in other activities, including animal husbandry and poultry, which can sustain their income in the short run. This is because almost 100 percent of people in cocoa producing areas can still earn an income from selling alternative cash crops.

Developments in the kina exchange rate (appreciation or depreciation) play a pivotal role in the determination of final kina receipts of cocoa producers. In the paper by Kauzi and Sampson (2009), they found kina as a commodity currency, that is, the kina exchange rate is determined primarily by PNG's export commodities, including cocoa. These results indicate that producers in PNG are vulnerable to external cocoa price shocks. This was also confirmed during the survey when all producers interviewed confirmed that exchange rate fluctuations affect the kina price they receive. Since the floating of the currency in 1995, cocoa and other agricultural commodity producers have confirmed receiving higher returns in kina, compared to the 'hard kina policy' period from 1975 - 1994.

3.2.2 Prices and Cultivation of other commodities

As the price of other competing cash commodities increase the survey found that producers divert some of their resources, including labor to the production of that commodity. The producer has the choice of producing other commodities to reap short-term benefits with the increasing price while abandoning their cocoa gardens, resulting in the fall in production and supply of cocoa. For example, in the cocoa producing provinces, if the prices of cocoa drops or remain stagnant while the price of other cash crops like copra, betelnut, banana, etc. increase, smallholder producers switch to producing those other cash crops whose prices are high, since their production is not tied down to any contractual obligations. The sale of fresh food also provides cash income to more households than any other activity as 100 percent of rural villagers live in households where income is derived from the sale of fresh food. Therefore, there is an inverse relationship between the price of other fresh farm food and the supply and production of cocoa. This was confirmed through the BPNG survey with almost 80 percent of cocoa producers interviewed expressed that when prices of other commodities that they grow increase, for example, copra, they tend to produce more copra.

Lower prices of cocoa, results in people switching to other alternative cash crops and livestock.. Photos: Aba and Aipi

Cocoa is also intercropped with other trees, plants and staple garden foods. For example, casuarina (which is a legume tree that produces nitrogen essential for plants) and coconut trees are planted together with the cocoa trees for shade and nitrogen intake. Apart from cocoa, other marketable commodities are produced in the same blocks, which they can consume and sell at the local markets. All the producers surveyed reported that they grow other crops, alongside cocoa plots. Some of the produce is consumed, while surplus is sold for extra income. The time and number of labor that is used in the production of these other commodities differs between cocoa flush and ordinary months. During cocoa flush, the entire family labor is employed in the cocoa blocks with longer hours of work, while time and the number of man power used for the production of other competing cash crops drop.

3.2.3 State and Use of technology

Smallholder cocoa blocks rarely use machinery and tractors; they use simple hand tools, such as wheelbarrow, bush knives, spades and pruning knives. They also use drying sheds that are built purely with bush materials along with manual fermentation methods. The process takes longer and is labor intensive during cocoa flush. For example, the process of drying cocoa beans is done through a very simple sun-drying process and or heating methods. On the other hand, the plantations use more sophisticated technology and inputs for harvesting, fermentation and drying processes.

3.2.4 Use of Chemicals

All smallholder cocoa farmers interviewed do not use chemicals like fertilizer, insecticide or pesticides. This is to maintain the quality and the natural flavor of PNG organic cocoa, which is supported by the Cocoa Board of PNG. They want to maintain a stable supply of organically grown cocoa and raise the profile of PNG cocoa in the world market. The land is naturally fertile but in-planting of other crops competing for the same nutrients could result in reduced production of cocoa.

3.2.5 Communication

One of the vital tools used in the cocoa production process is the use of mobile phones. The head of the cooperative society or lead farmers have a mobile phone through which they communicate to share vital market information like cocoa prices, availability of transport, weather conditions and information about visits by extension officers to their member farmers. They use mobile phones to contact vehicle owners to transport their cocoa beans to the market. Also they are able to communicate with the extension service officers about any problems like diseases, natural disasters, etc. Introduction of cheap and affordable mobile communications in the country has served the industry really well.

Simple tools like spades, wheelbarrows, knapsack sprayer, scissors, drying sheds, and bush knives etc, are commonly used by the smallholders. Photos: Aba, Aipi and Kauzi

3.2.6 External Support

Overall cocoa production in PNG peaked in 2005/06, but since then remained relatively stagnant. The decline in productivity in PNG has been a concern to the industry so the Cocoa Board with the assistance of the European Union (EU) and other international organisations, attempted to identify and recommend measures to address the declining productivity and other aspects of cocoa production, including the quality of cocoa. There are also other support from the National Development Bank (NDP) for cocoa development and processing, while EU supplied 12 million seedlings to ARB in 1999, with respective local Member's of Parliament (MPs) support to fund cocoa projects in their electorate in Madang and ESP. Appropriate

technologies developed by CCI are available, including plant material, pest and diseases control measures, nutrition and processing techniques and extension services. The World Bank through its Productive Partnerships in Agriculture Project in Papua New Guinea is implementing the project to assist the Cocoa Board and other stakeholders in the industry to improve the livelihoods of smallholder cocoa producers through the improvement of performance and the sustainability of value chains in cocoa-producing areas. There are three components to the project. The first component is institutional strengthening and industry coordination with an aim to improve the performance of sector institutions and to enhance industry coordination in the cocoa sector. Existing stakeholder coordination in the industry will be consolidated to address short and long term issues such as sector governance, skills development in the industry, improvement in extension services, industry strategy on threats to quality and quality promotion, information within the industry, market development and crop diversification. The second component of the project is productive partnerships, with an aim to increase the integration of smallholder producers in performing and remunerative value chains, by developing and implementing productive alliances between smallholders and the private sector aiming at improving market linkages in the project areas. The third component of the project is market access infrastructure. The objective of this component will be to improve market access for smallholder cocoa growers in the areas targeted under the project. The project is currently being implemented in pilot provinces in the country.

3.2.7 Labour input and return on labour

Labour in the cocoa sector is mainly members of immediate and extended family with no 'formal employment' of outsiders, on average 108 people per 35 hectare block of Cocoa. There are on average 140 members in each cooperative society, 16 families with 10 members in each family. The average production per family per hectare per year is 300-500 kg[1]. Of the total 541 labour force, 13 percent consists of block holder (head), 10 percent are spouses[2], 21 percent are children above 15 years old, 14 percent are children between 10 – 14 years old, 14 percent are children 10 years old, 3 percent are relatives over 15 years old, while 3 percent are relatives under 15 years. According to the survey results, some smallholders who employ people consist of only 11 percent of total workforce in the cocoa industry. With no help from modern tools, like tractors, the limited family manpower is dedicated to working on the existing blocks, which is sufficient to cater for their basic needs and meeting their communal obligations. Labour is sometimes diverted (whole) or split to other customary obligations. This results in the low or non-availability of labour, especially during harvest time, which could impact negatively on overall production.

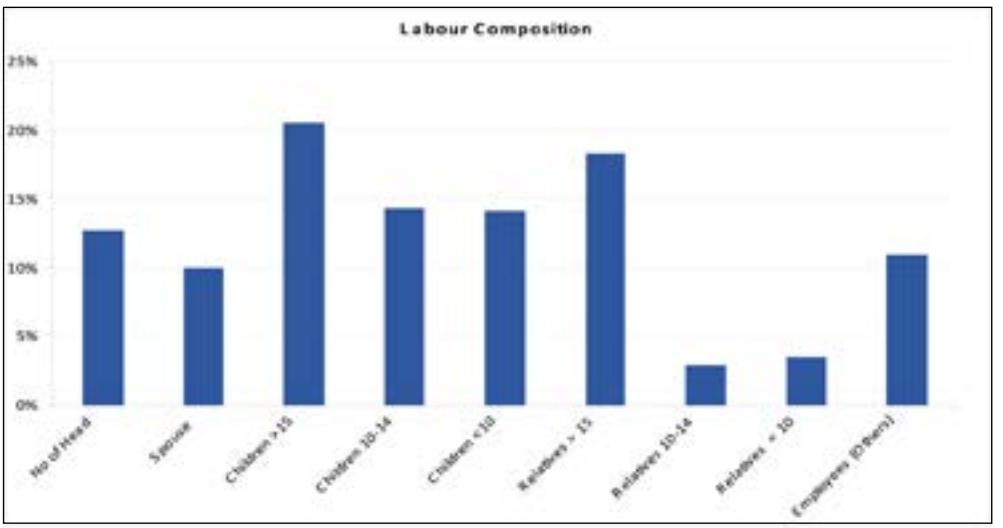
The return to producers from their involvement in the production of cocoa also determines how much they can produce. If the return to labor is low, the producer

[1] Can vary between provinces, but this is the average of all the surveyed provinces.

[2] The head of the family and spouse did not correspond because some block holders are single and while some spouses have passed on.

may decide to switch to other alternative commercial activity, which can be financially rewarding for the producer in the short run. This diverts labour participation away from cocoa production, which can cause a fall in production.

Chart 3: Labour Composition



Source: Bank of PNG survey data

3.2.8 Number of producers

As more and more smallholder producers are involved in cocoa production the larger the amount of cocoa produced and supplied for exports from PNG. For smallholders, a standard family unit consists on average of 10 members can have up to 2-3 hectares of cocoa plots. If the producer sees that the area is big, he/she decides to employ other people, mainly extended family or relatives, to work in the cocoa garden and harvest during cocoa flush and pay them in kind or cash. Cocoa production also increases when settlers from other non-cocoa areas migrate to cocoa growing areas and involve in cocoa production. The number of smallholder producers varies from time to time, depending on their mood and need to involve in cocoa growing and production. However, with the blocks and plantations, the situation is different; the number of producer is fixed over a certain period of time. For example, it can take long period of time and hard work for a smallholder to become a block holder or a company to enter the plantation sector. The reasons for the entry of new producers differ. If the number of producers increases without expanding the existing acreage, total production will remain stagnant or could decline. One of the major hindrance of new smallholder farmers or expansion of existing cocoa blocks is access to limited land.

3.2.9 Management skills and time management

Good management skills and practices are ingredients to improving productivity. The Cocoa Board and CCRI have an impressive network with smallholders and cooperative societies, through which vital market information on cocoa production is shared. This network forms the basis through which the Cocoa Board implements its extension services. Most of the producers are taught the basic tenets of cocoa production, how to manage their blocks, time, how to manage their returns from the blocks, and how to manage other competing and alternative cash crops in their blocks. Most of the farmers are members of a cooperative society. The cooperative societies are also part of the Cocoa Growers' Cooperative Societies. They are also members of a number of savings and loans societies like the Growers Saving's and Loans Society and some other Savings and Loans Societies. The cooperatives are used as platforms to educate each member on important management skills and through which members gain general farming techniques from extension officers. Almost 50 percent of the incomes are saved in one of these savings and Loans society, while the remaining are spent on reinvestment into the cocoa blocks, family daily sustenance, and other customary obligations. The ability of the farmer to manage his block is further enhanced by extension services provided by the Cocoa Board regional offices, via frequent visits and training to all members of the cooperative societies and linking them via the network of cocoa growers. Time management has become a critical factor in the cocoa production process and has improved considerably among the out-growers as a result of formation of cooperative societies through which individual members challenge each other if members are found to be non-committed. They follow simple schedules and divide their time among other activities, including tending to other crops. They do not commit 100 percent of the time to the cocoa block.

The number of producers in the small holder segment of the cocoa industry are mainly family members. The higher the family members, the high the production level.

3.2.10 Customs/traditions

Traditional obligations like contribution to bride price payment, death, compensation etc. forces people to work on their cocoa plots to have at least something to contribute as their part of community obligations. Also it was learnt that traditional practices like sorcery and reprisals play some part in the production process. Fears of sorcery and reprisals can lead to absence from work in the cocoa blocks, which can affect production. Those people believed to practice sorcery are chased out from their blocks and the blocks are abandoned or taken over by someone else.

3.2.11 Inputs and prices of inputs

To enhance the production of cocoa and maintain the same level of production, appropriate inputs are needed, including access to financial capital. The cocoa producers use inputs such as land, fertilizers, herbicides, knapsack spray, spades, bush knives, pruning tools, labour, wheel barrows, trucks etc. to enhance production. The use of inputs differs among the two types of producers. For example, the smallholder producers mainly use hand tools such as spades, grass knives, driers, knap-sack spray, canvas, and wheel barrow, while the plantations use complicated inputs, including labour. The plantations use trucks, tractors, electric pulpers, driers and canvas etc. However, the cost of these inputs have increased significantly over time making it expensive and almost impossible for smallholder producers to buy, for instance, a bag of fertilizer to enhance production. Some of the inputs, especially hand tools that they use are very old and are costly. For plantations, cost of labour has gone up, infrastructure like roads and bridges are falling apart, spare parts and maintenance cost have increased. The increases in cost have forced some of the plantations to operate at break-even point while others have shut down due to landownership issues and continuous neglect of infrastructure like roads and bridges. Some of the plantations were handed over to local land owners under the Governments land acquisition scheme introduced in 1975.

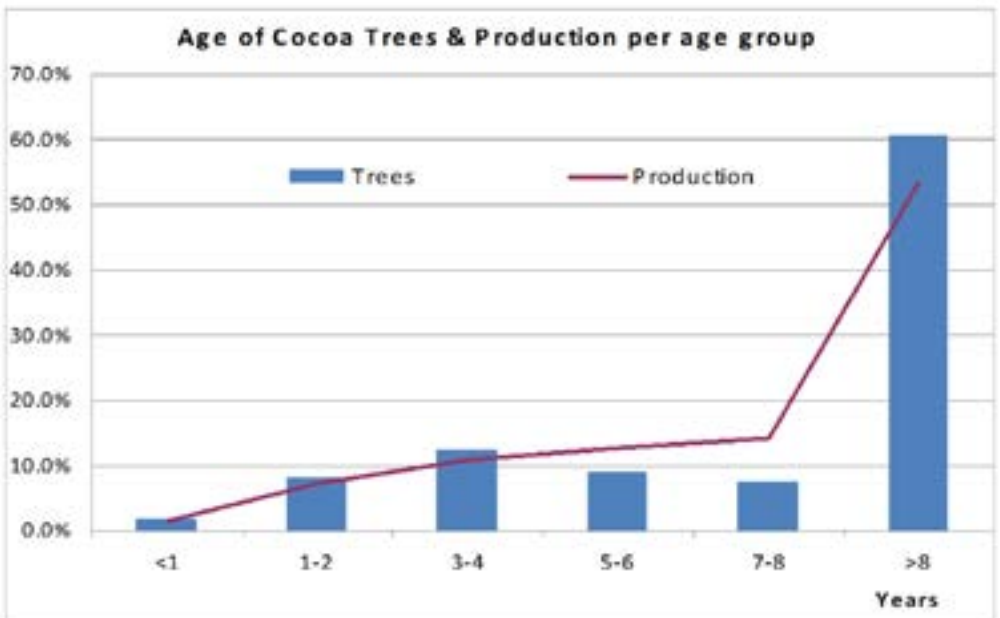
3.2.12 Land accessibility;

The smallholder cocoa farmers are traditional landowners and they have adequate land to plant enough cocoa trees. The combined cooperative societies have adequate land, if fully cultivated, has the potential to increase production up to 15 tonnes per year. Currently about 175 thousand hectares of land is being used to plant cocoa. They have plans to expand but the hurdle is lack of manpower, financial support and appropriate capital-intensive farming techniques like tractors etc. and vital infrastructure like roads and transport. Of the total land area, some are reserved, while in-planting is common, where other crops are planted in between cocoa trees. Having access to other competing cash crops, the land fertility could be used up faster to the detriment of long term cocoa cultivation.

3.2.13 Cocoa tree stock and age

A cocoa tree if looked after properly could have a lifespan of up to 100 years. Of the surveyed sample, 5 percent are under 1 year, 2 percent under 2 years, 3 percent under 4 years, 15 percent under 6 years, 17 percent under 8 years, and 60 percent above 8 years. This indicates that almost 83 percent of the trees are of bearing age and should bear cocoa pods. Almost all the old and aging trees are removed and replanted, while continuous pruning is essential to eradicate the threat of cocoa pod borer. The farmers also want to maintain production by cleaning and taking care of the cocoa trees.

Chart 4: Age of Cocoa trees and Production per age group



Source: Bank of PNG survey data

3.2.14 Weather patterns

Cocoa is grown in the 'cocoa belt' – between 10 - 20 degrees north and south of the equator. The cocoa tree needs shade, warm and humid climate that is why it grows only in tropical areas where it rains a lot and the temperature is right. PNG has the right amount of rainfall and climatic condition to grow cocoa. Production by smallholders could also be affected by changes in weather patterns. It is also a concern that unusual weather patterns disrupt seasonally higher production, like the El Nino or unusually wet weather conditions could slow down production. Global warming can also cause disruptions to the normal weather and affect production. It has become increasingly necessary to update the smallholders with the latest data and information on the weather patterns in PNG on a regular basis.

4.0 Constraints

The Cocoa industry faces multitude of challenges like other tree crops, some of the main challenges are listed below;

4.1 Cocoa pod borer

The cocoa pod borer (CPB) disease emerged in mid-2006 in ENB and was detected later at Aitape in West Sepik Province and is slowly spreading to other provinces. The CPB, also known as Cocoa Moth, is caused by the insect Conopomorpha cramerella. CPB attacks both young and mature cocoa pods. A common symptom of infested pods is unevenness and premature ripening. Infestation of young pods results in heavy losses because the quantity and quality of the bean becomes seriously affected. Since it was first noted, it became a serious threat, causing vast losses in the cocoa industry and now affects some cocoa producing provinces in PNG. The spread of CPB is directly responsible for the decline in the production of cocoa in PNG. Although, the control of cocoa pod borer is difficult; efforts are now focused on not full eradication but managing the spread of the disease, including an integrated approach where all key stakeholders like the government, businesses, farmers and CCRI are a party to managing the spread of CPB. The integrated approach includes good crop hygiene, early pod harvesting, insecticide applications, insect trapping and reducing the number of hectors per farmer to manageable levels.

4.2 Lack of Government assistance

The Government's key social responsibilities like providing good roads and bridges, facilitating the markets for produces, providing frequent technical expertise, providing direct financial assistance, subsidizing the costs of inputs, providing reliable electricity and transportation are literally absent. Most of the farmers interviewed expressed concern in the manner in which the Government has neglected the farmers, who produce cocoa to bring in foreign reserves, directly employing people who would not have been otherwise employed in the formal sector, and help wealth creation for the country. Apart from some help given by organisations like the Cocoa Board, CCRI and some businesses, direct Government help has not been forthcoming. This has provoked the farmers to produce on a 'hand-to-mouth' basis, where whatever they produce is spent and there is no incentive for sustaining the industry in the long run.

4.3 Dilapidating Conditions of Infrastructure (roads and bridges)

In most of the cocoa producing provinces, the conditions of existing infrastructure are severely poor. The BPNG survey team had to travel to very remote areas where

the road access have been build by the cocoa farmers themselves in order to access the market. This is due to continued neglect by subsequent governments since independence. For example, roads leading into some of the cocoa producing areas are in a state where the farmers have to carry the bags of dried cocoa beans to the nearest buying points. Roads are one of the most important asset the people use to transport their produce to the nearest buying point. Poor roads mean, delay in transportation of cocoa production, and delay in income for the poor farmers. With very bad road conditions, partly caused by heavy rainfall and years of neglect has made the transportation of cocoa to and from the cocoa producing areas even more difficult. This is affecting the cocoa supply to the buying points and export volume. Poor transportation system is one of the key problems for most of these cocoa farmers, where the road conditions are bad, making transportation of the cocoa beans to the market doubly difficult.

4.4 Absence of Financial inclusion

All the commercial banks operating in the country turn a blind eye on the plight of the cocoa producers to access financial services. Most of the farmers interviewed expressed that this is having an impact on their decisions to expand their blocks and production. Therefore, most of the smallholder cocoa producers either spend all they earn or if they decide to save, they save it elsewhere - not with a bank. For some that save in a bank, the distance and time taken to go to the nearest branch is almost a day, which further discourages them to bank their income from cocoa. The commercial banks stringent guidelines and increased requirements to open new accounts, has made it permanently impossible for smallholder producers to bank their income.

4.5. Lack basic accounting and management skills

From the survey, it was obvious that most of the farmers lack basic accounting and management skills, on how to manage their cocoa blocks and income they earn from it. The income they earn is directed towards the immediate needs of the family, while there is no savings. With a little help and an increase in awareness on the accounting and management skills, smallholder farmers can manage to sustain their cocoa block in the future.

5.0 Methodology

As opposed to traditional static models such as Nerlovian (1958) model to capture supply responses, cointegration and error correction model which is a dynamic model, is used in this paper to study both the short and long run effects of changes in international price and other non-price factors to supply of cocoa exports in Papua

New Guinea. Though a lot of variables which are likely to affect production of cocoa were identified during the field survey, time series date for these variables were not available, consequently, variables with available time series data were used to establish a supply response function for the cocoa industry in PNG.

5.1 The model

Using a similar model as that of Nkang, Abang, Akpan and Offem (2006), to model the supply response of cocoa in Nigeria to changes in international prices of cocoa and other variables, the supply response of cocoa to international price changes and other variables will be calculated for Papua New Guinea. The model assumes imperfect substitution and is founded on traditional supply response theory with the exclusion of export subsidies and inclusion of non-price variables as in Tambi (1999) and Gbetnkon and Khan (2002) thus:

$$LnQE_t = \lambda_0 + \lambda 1 LnREP_t + \lambda_2 LnREPCopra_t + \lambda_3 LnTWY_t + \lambda_4 Trend_t + \lambda_5 SOI_t + \lambda_6 DummyPod_t + \mu_t \quad \textbf{(1.0)}$$

Where,

QE_t	=	export supply of cocoa measured in tonnes
REP_t	=	(REP_t/DP_t) the ratio of export price of cocoa to the domestic price index.
$REPCopra_t$	=	($REPCoprat/DPI_t$) the ratio of export price of copra to the domestic price index.
TWY_t	=	trade-weighted income of major importers of Papua New Guinea cocoa exports.
$Trend_t$	=	trend variable to capture major technological changes in production and export processes.
SOI_t	=	Southern Oscillation Index[3] capturing weather patterns in Papua New Guinea.
$DummyPod_t$	=	Dummy variable to capture the impact of Pod Borer disease on production and export of cocoa in Papua New Guinea.
μ_t	=	stochastic error term assumed to be independently and normally distributed with zero mean and constant variance.

A priori, $\lambda_1, \lambda_3, \lambda_4, \lambda_5 > 0$, while $\lambda_2, \lambda_6 < 0$

[3] The Southern Oscillation Index (SOI) refers to the air pressure differential between Darwin and Tahiti, which drives trade winds. When this index is particularly low, this is called an SO event, and trade winds will be low. Periods of high water-surface temperatures and low air pressure differentials are called ENSO events which typically are associated with droughts in western Pacific countries, including Papua New Guinea. Rainfall in Papua New Guinea is determined by the long run EL Nino-Southern Oscillation (ENSO) system

Time series data are known to be non-stationary, as such any estimates of ordinary least squares (OLS) regression are known to produce spurious results with high R^2 and significant variables, however very low Durbin Watson statistics. Error correction mechanism (ECM) models have been known to overcome problems of spurious regressions caused by non-stationarity of the time series data and also provide information for both the long-run relationships and short-run dynamics in the model. The model adopts Engle and Granger (1987) two-step procedures in establishing co-integration. According to "Granger Representation Theorem", establishment of co-integration implies error correction representation of the model.

As a first step, the stationarity of variables used in the model are tested using the Augmented Dickey-Fuller (ADF). The following equation specification is applied for the ADF test;

$$\Delta Y_t = \alpha_o + \delta Y_{t-1} + \sum_{i=1}^{k} \lambda_i \Delta Y_{t-i} + \mu_t \qquad \textbf{(2.0)}$$

Results of the ADF test are presented in table 1.

Table I: Results of Augmented Dickey Fuller (ADF) unit root tests for individual series.

Variable Level	ADF statistics	Variable First Difference	ADF statistics
$LnQE_t$	-2.929	$\Delta LnQE_t$	-6.264***
$LnREP_t$	-2.079	$\Delta LnREP_t$	-5.874***
$LnREPCopra_t$	-2.235	$\Delta LnREPCopra_t$	-6.908***
$LnTWY_t$	-3.170	$\Delta LnTWY_t$	-3.289*
Test Critical values			
	1% level	-4.273	
	5% level	-3.558	
	10% level	-3.212	
Note			
***	represents 1 percent significance level		
**	represents 5 percent significance level		
*	represents 10 percent significance level		

Source: Author's calculations

The ADF test results indicate that real export price of copra (REPCopra), the ratio of export price of cocoa to domestic price index (REP), log of export quantity of cocoa (LnQE) and the trade weighted income of Papua New Guinean's major cocoa importing countries (TWY) are stationary at first difference, hence I(1) variables.

Table II: Results of ADF tests on residuals of cointegrating regressions

Variables	Long-run coefficients (t-statistics)	Residual Level ADF statistics
$LnQE_t$ on $LnREP_t$	-0.202 (-3.166)***	-1.624
$LnQE_t$ on $LnREPCopra_t$	-0.191 (-2.591)**	-3.902***
$LnQE_t$ on $LnTWY_t$	0.259 (5.820)***	-4.916***
$LnQE_t$ on all three variables	see table III	-5.102***
Test Critical values		
	1% level	-3.654
	5% level	-2.957
	10% level	-2.617
Note		
***	represents 1 percent significance level	
**	represents 5 percent significance level	
*	represents 10 percent significance level	

Source: Author's calculations

Co-integration tests were done on the bi-variant variables on each of the three independent variables on the dependent variable using Engel and Granger (1987) two step procedure. First by establishing the long-run relationship of the variables, then testing the residuals of the variables using ADF for co-integration. ADF results run on the residuals of bi-variant models in table III shows co-integration between volume of cocoa (QE), REPCopra and TWY while there is no cointegrating relationship between real export price of cocoa (REP) and QE. Testing for co-integration of all 3 independent variable against the dependent variable establishes co-integration.

Table III: Estimates of long-run cointegrating regression and diagnostics, sample: 1977 – 2009, Dependent variable: $LnQE_t$

Variable	Coefficient	Std.error	t-statistics	Probability
$LnREP_t$	-0.011	0.077	-0.139	0.891
$LnREPCopra_t$	-0.033	0.076	-0.433	0.668
$LnTWY_t$	0.240	0.060	4.033	0.000
Constant	7.042	0.943	7.472	0.000

$R^2 = 0.5279$ adjusted $R^2 = 0.4790$ DW = 1.816
F (3, 31) = 10.807[0.000]
Akaike Information Criteria (AIC) = -0.831; Schwarz Criteria (SIC) = -0.650

Source: Author's calculations

Co-integration of variables surpasses spurious nature of the time series regression. The long-run co-integrating regression is presented in table III. In the long-run international export price of cocoa and the price of copra exports does not have any impact on the supply of cocoa exports, while income levels of Papua New Guinea's major cocoa importing countries play a significant role in determination of supply of cocoa exports. A 10 percent increase in trade weighted income of PNG's trading partner countries income levels would results in the increase of cocoa export volumes by 2.4 percent, i.e. supply response is inelastic.

Establishment of co-integrating properties of the variables in the model qualifies error correction specification of the model, according to Granger Representation Theorem. Accordingly the error correction mechanism (ECM) of the model can be specified as:

$$\Delta Y_t = \partial_0 + \partial_1 \Delta \bar{A} - \partial_2 (Y_t - Z_t)_{t-1} + \varepsilon_t \qquad \textbf{(3.0)}$$

Where

$\bar{A}$	=	the vector of explanatory variables
Y_t and Z_t	=	the co-integrating variables
∂_2	=	the error correction mechanism (ECM)
∂_1	=	the vector of parameters.

Using equation 3.0 results of the over-parameterised error correction model is presented in table IV. A 3 year lag period has been used in the over-parameterised model as harvesting of crop commences after 3 years from initial planting.

Table IV: Estimates of lover-parameterised error correction model (ecm), sample: 1977 – 2009, Dependent variable: $\Delta LnQE_t$

Variable	Coefficient	Std.error	t-statistics	Probability
$\Delta LnQE_{t-1}$	0.038	1.561	0.024	0.982
$\Delta LnQE_{t-2}$	0.186	1.727	0.107	0.921
$\Delta LnQE_{t-3}$	0.509	1.137	0.448	0.685
$\Delta LnREP_t$	-0.032	0.730	-0.043	0.968
$\Delta LnREP_{t-1}$	-0.542	0.683	-0.793	0.486
$\Delta LnREP_{t-2}$	-0.040	0.580	-0.069	0.949
$\Delta LnREP_{t-3}$	-0.360	0.630	-0.571	0.608
$\Delta LnREPCopra_t$	-0.378	0.624	-0.606	0.587
$\Delta LnREPCopra_{t-1}$	-0.018	0.491	-0.037	0.973
$\Delta LnREPCopra_{t-2}$	-0.108	0.315	-0.342	0.756
$\Delta LnREPCopra_{t-3}$	-0.022	0.285	-0.079	0.942
$\Delta LnTWY_t$	3.908	8.704	0.449	0.684
$\Delta LnTWY_{t-1}$	-2.549	5.389	-0.473	0.668
$\Delta LnTWY_{t-2}$	-4.922	7.958	-0.618	0.580
$\Delta LnTWY_{t-3}$	-1.187	9.618	-0.123	0.910

ECM_{t-1}	-1.480	2.048	-0.723	0.522
SOI_t	-0.025	0.202	-0.125	0.909
SOI_{t-1}	0.102	0.181	0.562	0.614
SOI_{t-2}	-0.105	0.206	-0.511	0.645
SOI_{t-3}	-0.006	0.255	-0.025	0.982
Dummypod	0.026	0.492	0.053	0.961
$Dummypod_{t-1}$	0.267	0.694	0.385	0.726
$Dummypod_{t-2}$	0.252	0.709	0.356	0.746
$Dummypod_{t-3}$	-0.521	0.565	-0.921	0.425
Constant	0.218	1.213	0.180	0.869
Trend	-0.000	0.026	-0.010	0.993

R^2 = 0.853 adjusted R^2 = -0.368 σ = 0.239 DW = 2.172

F (3, 31) = 0.698 [0.743]
Akaike Information Criteria (AIC) = -0.497; Schwarz Criteria (SIC) = 0.728
Source: Author's calculations

From the general over-parameterised model, an economically interpretable model was generated. Lags were reduced and variables were omitted to achieve a parsimonious ECM model. The reduction process was carried out using intuition and statistical significance and not based on any economic theory or scientific production theories. The parsimonious reduction process made use of stepwise regression, subjecting each stage of the reduction process to several diagnostic tests before arriving at an interpretable model which is presented in table IV.

Table IV: Estimates of parsimonious error correction model (ecm), sample: 1977 – 2009, Dependent variable: $\Delta LnQE_t$

Variable	Coefficient	Std.error	t-statistics	Probability
$\Delta LnQE_{t-1}$	-0.342	0.190	-1.797	0.086
$\Delta LREP_t$	-0.232	0.115	-2.019	0.056
$\Delta LREPCopra_{t-3}$	-0.114	0.061	-1.868	0.075
ECM_{t-1}	-0.592	0.241	-2.459	0.022
SOI_{t-1}	0.119	0.039	3.060	0.005
$DummyPod_{t-3}$	-0.329	0.145	-2.268	0.034
Constant	0.058	0.029	2.008	0.057
Diagnostic tests				
Jarque–Bera F-statistics			3.3790[0.185]	
B-G LM test F-statistics			0.9430[0.406]	
ARCH test F-statistics			0.0004[0.984]	

R^2 = 0.707 adjusted R^2 = 0.628 σ = 0.125 DW = 1.876

F (3, 31) = 8.867 [0.000]
Akaike Information Criteria (AIC) = -1.117; Schwarz Criteria (SIC) = -0.787
Source: Author's calculations

The parsimonious model has a better fit compared with the over-parameterised model as indicated by a high value of the F-statistics (8.867), which is significant at the 1% level of significance compared with the F-statistics (0.698) of the over-parameterised model, which is insignificant.

The structural variables of the reduced model explain export supply of cocoa better than the over-parameterised model as indicated by the values of their adjusted coefficients of multiple determinations. Specifically, the adjusted R^2 for the reduced model (0.628) is higher than the adjusted R^2 of the over-parameterised model (-0.368). Similar evidence is given by the value of the standard error of the regression (σ), Durbin-Watson (DW) statistics for first-order serial correlation and the two model criteria (that is Akaike & Schwarz information criteria).

Diagnostics test were applied to the model in order to test the validity of its estimates. Apart from the DW test for first order serial correlation three test were applied on the residuals of the parsimonious model.

The Jarque-Bera Normality test on the residuals, with F-statistics of 3.379, could not reject the null hypothesis of normality in the residuals, as indicate by the level of significance shown in table IV.

Bruesch-Godfrey serial correlation Lagrange Multiplier (LM) test for higher order serial correlation with a calculated F-statistics of 0.943 could also not reject the null hypothesis of absence of serial correlation in the residuals.

Finally, the Autoregressive Conditional Heteroskedasticity (ARCH) tests were used to test for heteroskedasticity in the error process in the model. The results of the calculated F-statistics (0.0004) indicated absence of heteroskedasticity in the model.

From the array of diagnostics tests the model is asserted to be well estimated and the observed data fits the model specification adequately, thus we expect that the residuals are distributed as white noise and the coefficients valid for policy discussions.

5.2 Discussions of the results.

The coefficient of the error correction term ECM_{t-1}, as expected has a negative sign and is significant at the 5% significance level. The significance of the error correction term supports cointegration and suggests the existence of long-run steady-state equilibrium between cocoa export supply, real export price of cocoa, real export price of copra and trade weighted income of major trading partners. The results indicate

that 59.2 percent of previous year's disequilibrium from the long-run equilibrium of export volume is corrected in the current period. From short run dynamics, it takes almost 6 years for cocoa export supply to adjust to its long run equilibrium level. The speed of adjustment is sluggish.

Both the long and short-run estimates are consistent with the survey results. Price factors aren't influential in production and supply of cocoa exports. In Papua New Guinea, non-price factors are pivotal in the determination of cocoa production. In the short run price does weakly affect the supply and production of cocoa; however the sign on the coefficient is negative. Leaving aside the negative sign on the coefficient, the short-run model suggests that cocoa supply response to price movements of 0.232 is inelastic.

In the long run, trade weighted income levels of Papua New Guinea's major cocoa importing countries has a major influence on production and export supply of cocoa. According to the long run model, a percentage increase in trade weighted income levels of Papua New Guinea's major cocoa importing countries would result in an increase in cocoa export supply by 0.24 percent. The vice versa is true when trade weighted income levels of Papua New Guinea's major cocoa importing countries declines.

Though weakly significant; real export price of copra has an inverse relationship with the production and supply of cocoa in the short-run. According to the parsimonious model a percentage (increase or decrease) in the price of copra relative to the price of cocoa would result in a decline or increase in the production of cocoa by 0.114 percent. This was also confirmed by the cocoa growers during the field survey.

Weather also plays an important role in the determination of supply of cocoa exports in PNG. A positive sign on the weather coefficient implies good production during good weather and bad production during bad weather. This result is substantiated by growers during the field survey. According to the results, during good weather production and export supply increases by 11.9 percent while during bad weather conditions production declines by the same percent.

One of the major factors that recently had an influence on cocoa production was the Pod-Borer disease that affected production and export supply of cocoa. The Pod-Borer disease started affecting cocoa producing regions in 2006, and continues to be one of the major treats of cocoa production. According to the parsimonious model, the disease affected production by around 33 percent; the effects on production are felt fully after 9 months if no punitive measure is taken by the industry.

6.0 Conclusion and Recommendations

Apart from international prices of cocoa, the factors that affect production of cocoa differ. Non-price factors such as the ones listed above also affect the production and

supply of cocoa at the smallholder level. Given that the smallholders will sustain their daily living, they work in their blocks regardless of the fluctuations in the prices of Cocoa. However, the overall trend in production, both plantations and smallholders increased consistently, which indicate that the strategies, including extension services and farmers assistance methods deployed by the Cocoa Board is working. The cocoa growers now have a well established grower's network through the establishment of cooperative societies which has made extension services easier. There is growing world demand for fine and flavored PNG organic cocoa and the smallholders are adamant about maintaining the standard of fine flavor by growing and nurturing the cocoa plant organically. Almost all of the Cocoa Corporative Societies (CSS) have indicated during the survey that, growing organic cocoa to fetch premium market price is the way forward for the cocoa industry.

One promising aspect of cocoa production is the expansion to new areas and the identification of potential cocoa growing regions in the country like Karamui in Simbu province and other provinces unaffected by the pod borer disease. The threat that persists is the pod borer pest which in 2008/2009 caused a 50 percent decline in fermentary registrations and 50 percent decline in production. Currently major exporting companies have collaborated with the Cocoa Board, CCRI and grower associations to educate farmers on farm management skills to manage the disease; more assistance is however needed to contain it from spreading to other non-affected areas.

Furthermore, limited access to financial resources, lack of institutional capacity for development and market due to poor infrastructure has affected cocoa production. Years of neglect by successive government to provide basic infrastructural developments have hampered growers from actively growing cocoa. Governments need to provide better infrastructure so that growers can access better markets for cocoa. Lack of infrastructure and support from successive governments has seen cocoa production levels remaining stagnant over the years.

Trade weighted income levels of major trading partner countries play an important role in the determination of cocoa production and export supply; as a result cocoa farmers and exporters are exposed to external economic shocks. Developments in income levels of major cocoa trading partner countries of PNG determine how much cocoa is exported to these countries. In order to mitigate this problem, the government should encourage down-stream processing in the cocoa industry rather than exporting raw cocoa whose price is volatile. CCRI has done some research in trying to produce chocolate and has successfully done so. With more funding and marketing a reputable company could be engaged to operate a full flexed chocolate manufacturing operation in the country, this would mitigate any chances of exposure to external shocks.

Appendix 1. Survey Results

Supply Response of Cocoa in PNG - Field Trip Data

1. Houseold Data	BOIKEN/DAGUA LLG	TURUBU LLG	WEWAK LLG	NUMBO LLG	YARAPOS LLG	KANAWAGI	BANAB CCS	IYAL CCS	JAHIL CCS	MESSAM CCS	Bargam	ENB	TOTAL	Labour Composition
No of Head	19	10	3	5	1	1	10	24	11	26	13	9	**132**	13%
Spouse	17	7	3	5	1		5	13	10	25	9	9	**104**	10%
Children >15	44	29	6	15	2		10	28	3	41	2	33	**213**	21%
Children 10-14	21	10	4	6	1		8	6	9	52	21	11	**149**	14%
Children <10	19	3	5	7	1		3	30	20	17	39	3	**147**	14%
Relatives > 15	44	24	1	14	4	2	25		21	20	11	24	**190**	18%
Relatives 10-14	2	18	1	7	1					1			**30**	3%
Relatives < 10	6	0	0	2			18		10				**36**	3%
Employees (Others)	55	12	4	31	6	6							**114**	11%
Total manpower	*227*	*113*	*27*	*92*	*17*	*9*	*79*	*101*	*84*	*182*	*95*	*11*	**1037**	100%
														0
2. Crops Cultivated														
Cocoa Trees	52608	18741	1645	9245	17000	3000	9824	19648	13508	37454	27016	73803	**283492**	
Other Perennial (Coconut) Trees	11400	3190	154	80	3000	100	Yes	Yes	yes	yes	Yes	Yes		
Annual Crops (Vannilla and Others)	654	5050	210	1340	7000	150	Yes	Yes	yes	yes	Yes	Yes		
Total Area (HA)	106	30	3	18	*27*	*6*	*16*	*32*	*22*	*61*	*44*	*120*	**485**	
3. Age of Cocoa Tree (Current)														
<1	0	500	0	0			307	675	0	3677	0		**5159**	1.9%
1- 2	17069	982	0	2000		500	0	1228	1228	0	0		**23008**	8.3%
3- 4	3616	1965	393	1510	16701		3991	2149	1842	614	1535		**34315**	12.4%
5- 6	1535	2628	0	3000		2100	614	3070	1228	4912	5526	860	**25473**	9.2%
7- 8	3042	0	300	0			0	614	1842	2763	12280		**20841**	7.5%
>8	29104	9107	1910	1300		400	4912	12587	7368	22305	5833	72820	**167646**	60.6%
		0											**276441**	100.0%
4. Yield/Production (kg) (1)	15210	9546	768	4677	8160	1848	491	1016	675	1714	1259	35580	**80944**	
Yield/Production (kg) (2)	14927	12080	0	0			491	1016	675	1714	1259			
5. Removal, Replanting & New Cocoa Tree														
Trees Uprooted (trees)	8178	734	200	167	0	105						3690	**1868**	24.9%
Trees replanted (almost 100% of trees uprooted are replanted)	8178	1134	200	167	0	105						3690	**1925**	25.6%
New tree (acreage)	4912	2342	0	0	0							15043	**3716**	49.5%
													7509	100.0%
6. Other perennial and annuals														
Kaukau	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
Yam	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
Vegetables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
Others	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
7. Inputs & Labor														
Fertilizer	No	No	No	No	No	No	nil	Nil	Nil	Nil	Nil	Nil		
Insecticide	No	No	No	No	No	No	nil	Nil	Nil	Nil	Nil	Nil		
Herbicide	No	No	No	No	Yes	Yes	nil	Nil	Nil	Nil	Nil	Nil		
Tractor (rent)	No	No	No	No	No	No	Nil	Nil	Nil	Nil	Nil	Nil		
Other tools (sharp, bush knife, spade, wheel barrow, etc.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
No. of workers	227	113	27	92	17	9	Yes	Yes	yes	yes	Yes	Yes	**81**	
8. Wealth Owership														
Cattle	No	No	No	No	No	No	Nil	Nil	Nil	Nil	Nil	Nil		
Pigs	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes		
Sheep and Goat	No	No	No	No	Yes	No	Nil	Nil	Nil	Nil	Nil	Nil		
HMCD	No	No	No	No	No	No	Nil	Nil	Nil	Nil	Nil	Nil		
Other (specific)	No	No	No	No	No	No	Chicken,	Chicken,	Nil	Chicken	Nil	Nil		
Other sources of income		Fish Pond, Poultry,	No	No	No	No	Nil	Garden	Yes, trade Store	Betel nut,	Yes, poultry	Yes, poultry, betel nut,		
9. General Comments	No clear roles of Commerce and DAL to deal with farmers. Price sensitive, replanting with hybrid, sell wet beans to local fermentary,disease spreading through and mgt is an issue. Looking to employ people in the farm,	Increase in price leads to increase in production, extension and improve production, pod borer has not arrived yet, buy cocoa from village people and sell to exporter, New industry - export dealers, dry bean dealers and wet bean dealers.	Prices change does not matter, keep on producing but mgt of blocks is a problem, Price change does not affect production, export to buyers and depend on buyers price, mostly, Garamut, Outspan, Winnie & Mendel, buyers usually hide	price sensitive, cocoa prices are high so people are removing coconut and vanilla to plant cocoa. price information.	Fear of using chemcial, no gov't assistance in other cash crops, maintain prodn at farm but fermentary holds bags for at least 28 days.	Change in price does not change production much	Produce only for daily sustenance, reinvestment into the Cocoa block, savings, customs, school fees	Poor road conditions, lack of producer incentives, dearer hand tools, long distance to the nearest bus stop and market,	Bad road conditions, need more government assistance although Cocoa board assistance is there, price distortion, assistance to export directly, need finance to help improve and extend blocks	Little or no assistance from government, poor road condition, savings, school fees, transport is poor, daily sustenance, reinvestment,labor shortage, customary obligations,	Change in lifestyle, mgt and extension work,customs, daily sustenance, savings, further developmentc hange in diet, clothes, school fees,	Cocoa is not price sensitive, pod borer affected production. Other crops like coconut (copra) betel nut etc. are usually grown as in-planting. The whether is right, management and extension services are excellent, trees uprooted are replaced, cocoa is the main cash crop, use of capital is limited to hand tools, and labor is own, there are still areas that needs to be extended. All of the CCS said they want to produce organic cocoa and that resulted in non-usage of fertilizers and other chemicals. Also change in lifestyle is one factor that drives them to work on the block. There are also potential areas that need to be expanded but there is lack of institutional capacity and financial support and subsidies for inputs, like tools.		

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