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南太平洋之效率與農業生產力成長探討—以美拉尼西亞國家為例

Efficiency and Agricultural Productivity Growth in Melanesian Countries of the South Pacific

歐維立

William Joerg Okekini

指導教授：陸怡蕙（博士）

黃芳玫（博士）

Advisors: Yir-Hueih Luh (PhD)
Fung-Mey Huang (PhD)

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Abstract

This study aims at identifying the sources of agricultural productivity growth and its determinants in the Melanesian countries of the South Pacific. Using Malmquist DEA Index, the FAO time series data of two outputs and three inputs are calculated to construct the agricultural Total Factor Productivity (TFP) growth patterns with its components during 1961 to 2005. The TFP change is calculated and is tested with the determinant variables for significance levels. The determinant variables are foreign aid, agriculture export, agriculture import, natural disasters and dummy variables. The empirical results show that each Melanesian economy has its own patterns of cumulative TFP growth. The results further indicate that the major source of productivity growth is technical progress rather than efficiency change. Regression results show that foreign aid has positive impacts on Fiji and Solomon Islands agriculture productivity. Agriculture export has significant influence on agriculture productivity in Fiji and Vanuatu, while agriculture imports have negative impacts on agricultural productivity of Vanuatu but has positive influence for Papua New Guinea. By using dummy variable, the result also shows that natural disasters do not have impacts on agricultural productivity in these economies. While some countries in the region benefited from their MSG regional trade organization, others have shown no influence on the TFP change. Solomon Islands have two distinct periods in the study that shows better TFP in 1962 to 1986 but poor TFP growth in 1987 to 2005. TFP growth in New Caledonia has three distinct periods and shows 1974 to 1989 has poor TFP growth. In order to raise agriculture productivity in the Melanesian region, appropriate land reform programs need to be implemented with the help of agricultural subsidies. To achieve the full potential from foreign aid in the

agriculture sector, aid flowing into the region needs to have proper coordination and alignment should be focused on the development needs of each country. An implementation of good policy programs with a vibrant domestic and international market will help farmers to boost the agricultural productivity in the region.

Keywords: *DEA, Malmquist Index, TFP change, Melanesian countries.*

Dedication

This Thesis is dedicated in the memory of my loving father, the late George R. Okekini. For his fatherly love, care, nurture and being a role model for me in the early years of my life. He departed me so early that we cannot share and feel the benefits and see my success from his great work. I LOVE YOU DAD… May Your Soul Rest in Peace.

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Chapter 1.0 Introduction

Similar to many developing countries around the world, agriculture is the major sector for the Melanesian countries' economies. Agriculture is seen as one of the major sector playing a key role in generating economic development and growth in Fiji, Papua New Guinea, Solomon Islands, Vanuatu and New Caledonia. According to Fleming (2005), agriculture sector within this region continues to play as the major employer of labor, provider of food, and is a significant contributor to export revenue to these countries. Except for New Caledonia, Melanesian countries had gained independence in the 1970's and 1980, and are different from other Pacific regional countries (Polynesia and Micronesia) with their agriculture resource endowments, agricultural exports, population size and cultural diversity.

In Melanesia, most people live in rural areas and depend solely on agricultural activities for their livelihoods, survival and are part of their daily living (Reddy, 2007). These countries are rich in land for agricultural production; however their major hindrance to agriculture growth is the spread of islands over vast oceans and their isolation from the main urban centers. The major concern is, since agriculture is the entity for livelihood and economic development how can agriculture productivity can be increased and properly coordinated with the nature of dispersed island settings of the region.

Agriculture productivity's primary importance to this region is to achieve higher yields, better quality farm products and higher income for farmers. Agriculture productivity to these countries is important for many reasons. Apart from providing more food, increasing the productivity of farms in the region has the prospect for growth. An

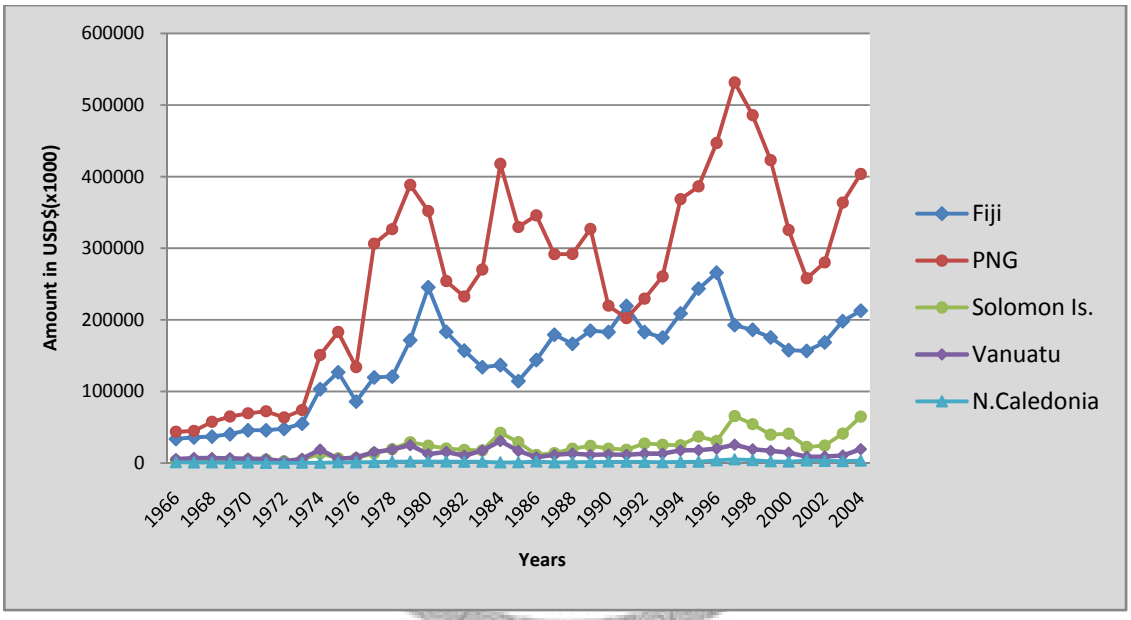
increase in a country's agricultural productivity implies more efficient distribution of scarce resources. The question to ask is whether agricultural productivity has been increasing over the past four decades in the Melanesian countries. Fleming (2007) study on agriculture productivity with four Melanesian countries, TFP estimates shows that no country has managed to achieve significant TFP growth over 1970 – 2002. This further suggests that there was no progress in the agriculture productivity in the Melanesian region.

Despite no progress in agricultural productivity in the recent years, agriculture sector was seen important to these countries before gaining independence. In the colonial era, four Melanesian countries were identified fit for plantation crops (coconut, palm oil and cocoa) as the main source of export and economic foundation. During that time the main source of employment within the agriculture sector has been self-employed smallholders producing their own food crops for home consumption and cash crops for export. Domestic food production is dominated by locally raised pigs, fish, root crops and bananas which remain to be the major provider of nutrients consumed although food imports have been increasing drastically over the years for some of the countries.

The agricultural sector in these countries has been the main contributor to the total GDP and traditionally the sector is the major source of foreign exchange through exports of commodities. In their small scale production compared to the rest of the world, Fiji is well known in the region for its sugar and coconut products. Papua New Guinea is famous for coffee, cocoa, coconut products, palm oil and palm kernel oil production. Solomon Islands agriculture production for export is mainly coconut products, cocoa, palm oil and palm kernel oil and Vanuatu's main agriculture earnings come from coconut

products, cocoa and recently beef export. New Caledonia's manufacturing and mining ranked highest to their total GDP while agriculture export is very minimal with beef production. Agricultural commodity exports still remain significant earners of export revenue (Fleming, 2005) to some of the countries in the region. Papua New Guinea and Fiji's agriculture export are higher compared to the rest of the Melanesian neighbors since 1966 to 2004 (refer to figure 1a).

Figure 1a Agriculture Export of the Melanesian countries (1966 – 2005)



Source: Food Agriculture Organization Statistics Database (FAO STAT) (2009)

1.1 Motivation.

Rural Melanesian population has engaged in agricultural production for centuries and food production has become part of their culture, life and is a way of living. Despite the high population growth and increased urbanization, agriculture sector still remain the main basis for livelihood and food production in these countries.

The Melanesian countries have rich natural resources available for potential growth in the agriculture sector, however their performance is relatively poor (Fleming, 2007 and Reddy, 2007). Fleming (2007) also adds that these countries have favorable resource endowments necessary for development but not sufficient to improve agricultural productivity growth and they have not achieved TFP growth in agricultural productivity.

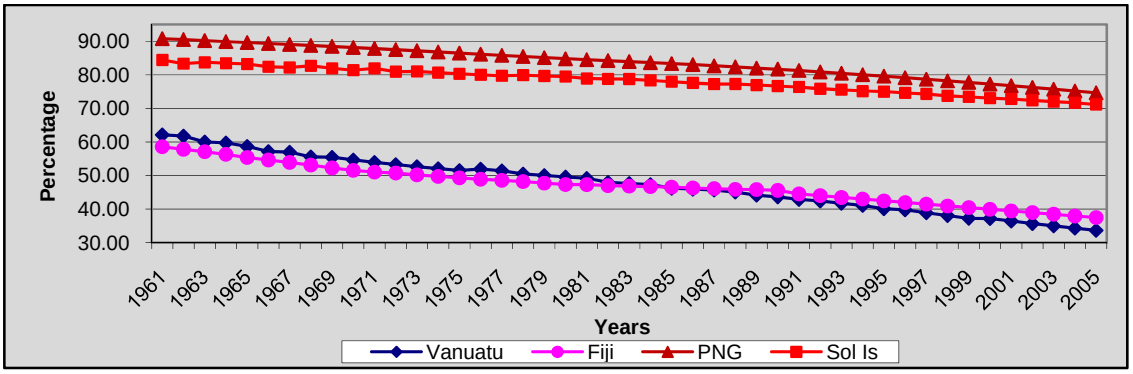
Apart from resource endowments, there are other important factors to agriculture development and growth that needs to be considered for making appropriate conclusions. For agriculture to drive forward in these countries, many interrelated factors need to be combined and analyzed. Despite the criticisms of Fleming (2007) on TFP growth in Melanesia, agriculture is still a major sector to these economies for living, survival and generating economic development and growth. Factors that need immediate attention includes investment in human capital and rural infrastructure, agricultural research and development, increase processing and technology, improved agriculture extension services, solving land tenure problems, planning and management of domestic and international markets. Other areas include improved financial services throughout each country, diversification of farming activities with mechanized inputs, appropriate response to natural and biological disasters, and strengthening of government institutional performance.

Liberalized global trading and exporting environments have pressed Melanesian countries to direct its agricultural production towards greater international competitiveness in existing markets (Fleming, 2005), yet it is a phenomenon to be achieved through proper policy planning and implementation. Importation of food products from developed countries have come under increasing pressure since most are

seen as product dumping into the region with low prices. Local farmers are always under threats with prices when imported products are cheaper than locally produced products. This is not a viable competition when production cost in domestic production is high, hence many farmers will leave the local food industry.

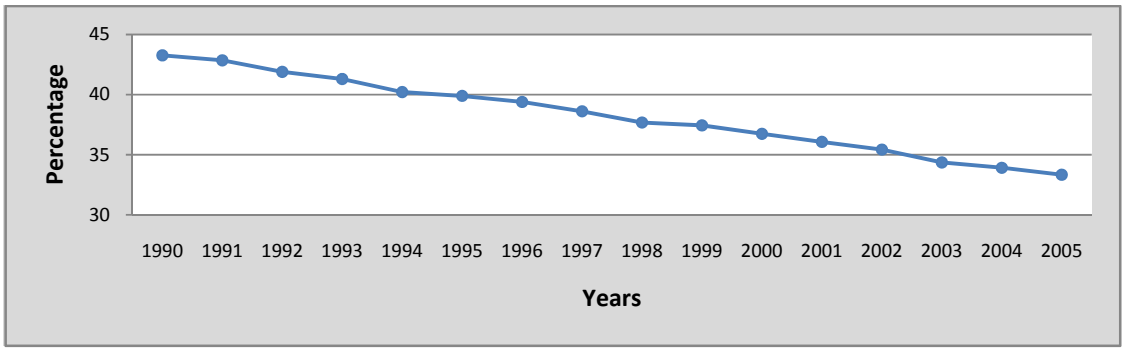
Statistics (FAOSTAT, 2009) revealed that percentage population of people involved in agriculture (compared to the total population) over the past four decades, has declined by 15 – 20 percent for Papua New Guinea and Solomon Islands. Fiji and Vanuatu agriculture populations have declined by about 25 percent (refer to figure 1b). Data for New Caledonia was not complete but shows some drastic decline over 1990 to 2005 (refer to figure 1c). The declining figures signifies that from 1961 to 2005, people have been diverting away from agriculture to other sectors of the economy or have moved in search of employment in towns and cities (Connel, et al. 2007) and hence there will be declines in agriculture productivity in the future. This new twist of urban migration has lead to the negative effects and declines of the agriculture percentage contribution to the total gross domestic product (GDP) over the years.

Figure 1b Percentage of Agriculture Population to Total Population in Four Melanesian Countries (1961 – 2005)



Source: FAOSTAT (2009)

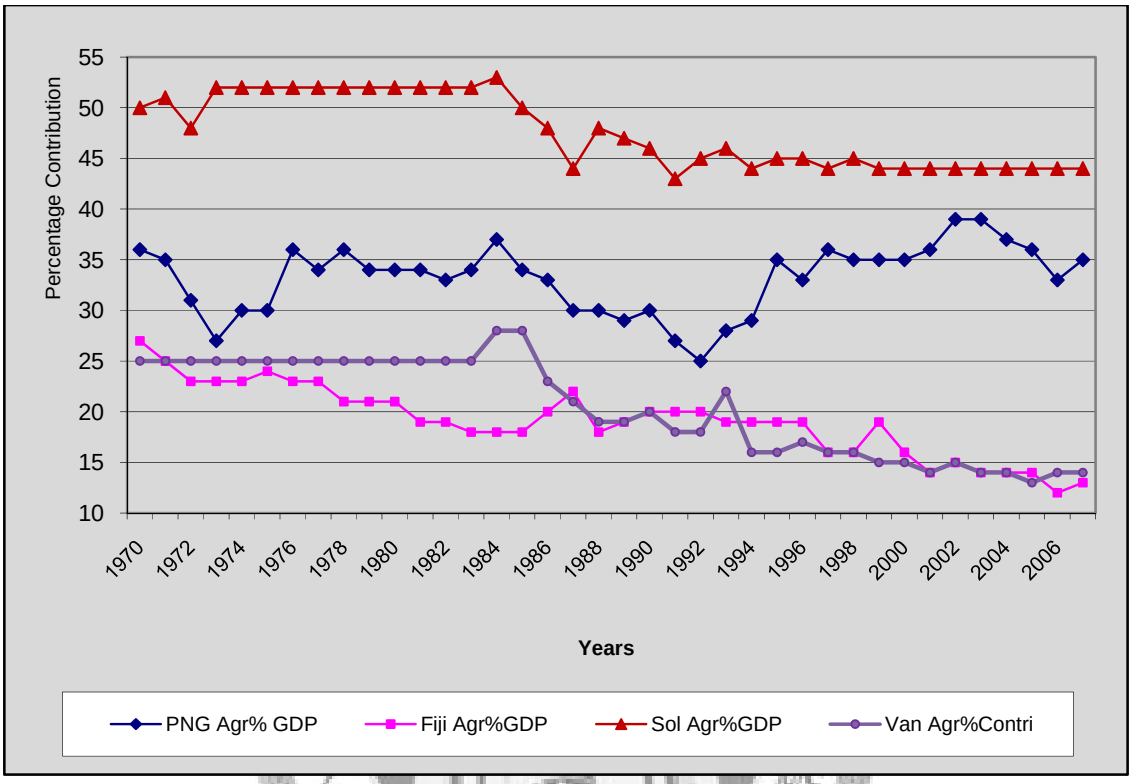
Figure 1c Percentage of Agriculture population to Total population for New Caledonia (1990 – 2005)



Source: FAOSTAT (2009)

There has been a declining trend in agriculture contribution to the total GDP from 1970 to 2006 in most Melanesian countries however, agriculture continues to play the importance of providing food and employment compared to other sectors. From the United Nations Statistics Division (2009), statistics shows that agriculture sector is the largest contributor to the total GDP in some countries in the region. Solomon Islands agriculture contribution to the total GDP is between 40 – 50 percent while Papua New Guinea is between 30 and 40 percent (refer to figure 1d). Fiji and Vanuatu's agriculture contribution to the total GDP is relatively low (10 – 30 percent) however, the importance of agriculture is immense since the percentage of population that lives in the rural areas still depends entirely on agriculture. Despite the declining trend over the study period, these countries continue to rely heavily on agriculture for export, and as such agriculture sector still remains the backbone of their economy. Time Series Data for New Caledonia is not available, however for 2003 estimates in the C.I.A World Fact Book (2009) shows that agriculture contribution to the total GDP is 15 percent.

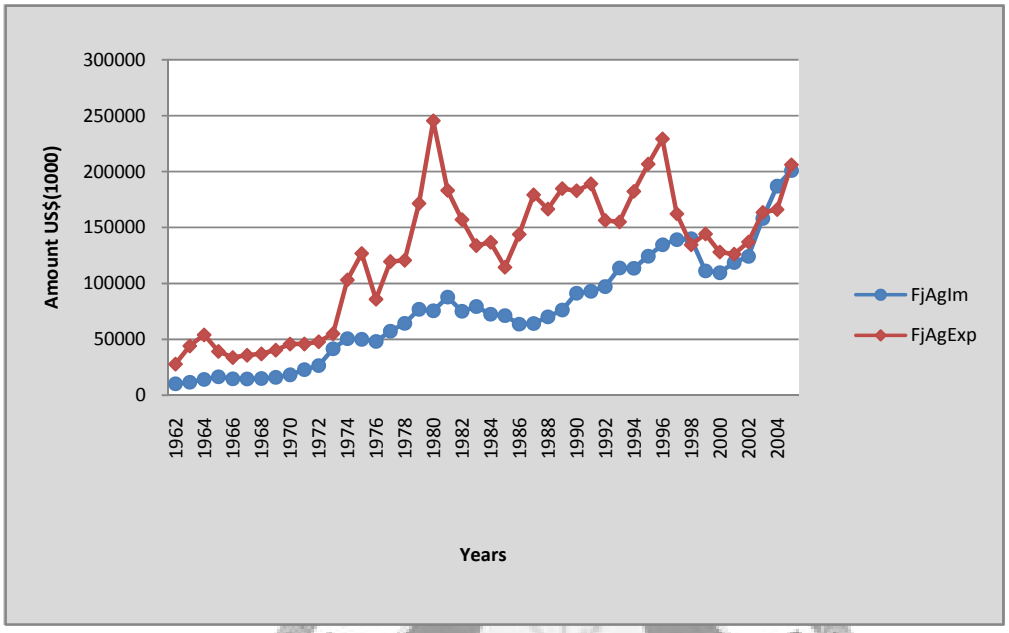
Figure 1d. Agriculture Percentage contribution to total GDP in Four Melanesian countries (1970 – 2006)



Source: United Nations Statistics Division (2009)

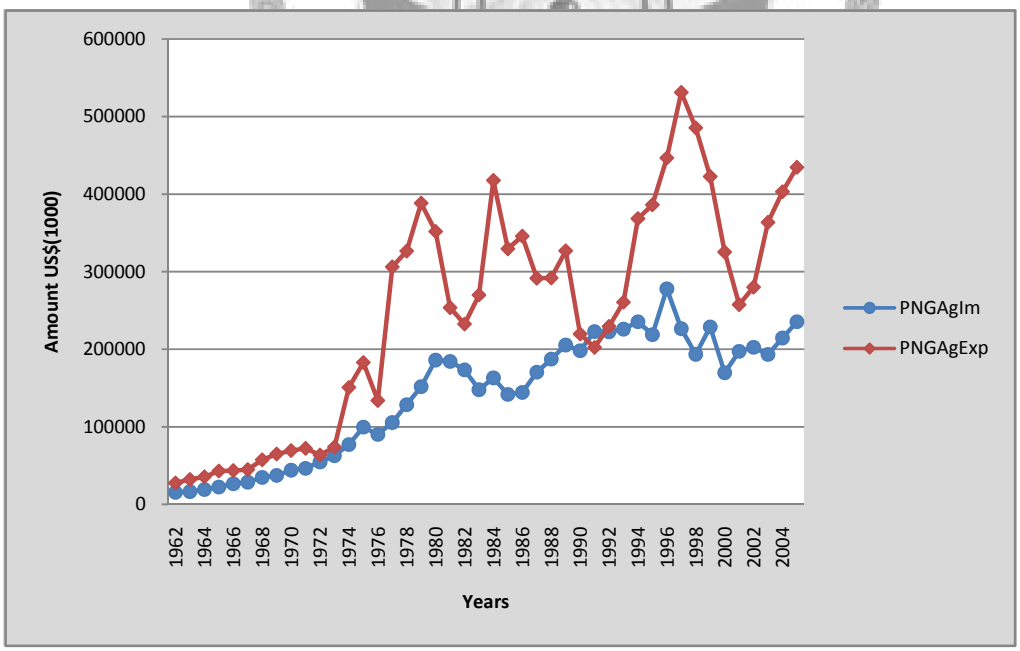
Agriculture exports have been fluctuating in all Melanesian countries over the four decades however the major concern is agricultural import (food) trends is catching up (refer to figures 1e – 1i) on the agricultural export trends. The fear is there will be further declines in the agricultural productivity in the region when agricultural imports will exceeds agricultural exports. According to the FAO Statistics, Fiji and Vanuatu's agriculture imports have already catch up with the agriculture exports and New Caledonia's agriculture imports has been increasing over the four decades while its agriculture exports had remained stagnant throughout the whole period. Papua New Guinea and Solomon Islands' agricultural exports are relatively high in the same period.

Figure 1e Fiji: Agriculture Exports and Imports (1962 – 2005)



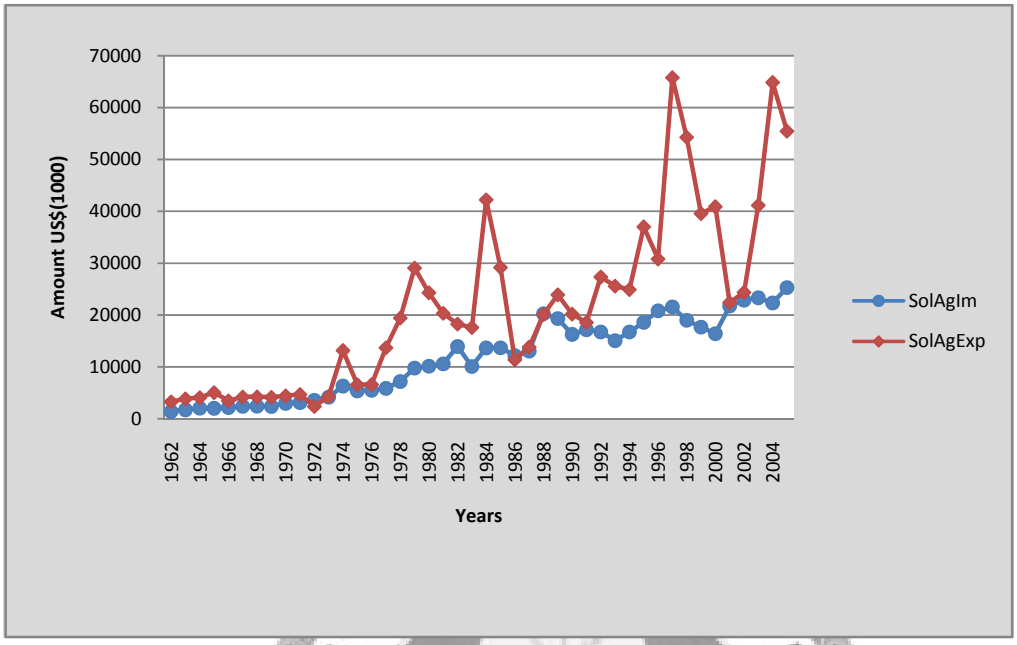
Source: FAOSTAT (2009)

Figure 1f Papua New Guinea: Agriculture Export and Import (1962-2005)



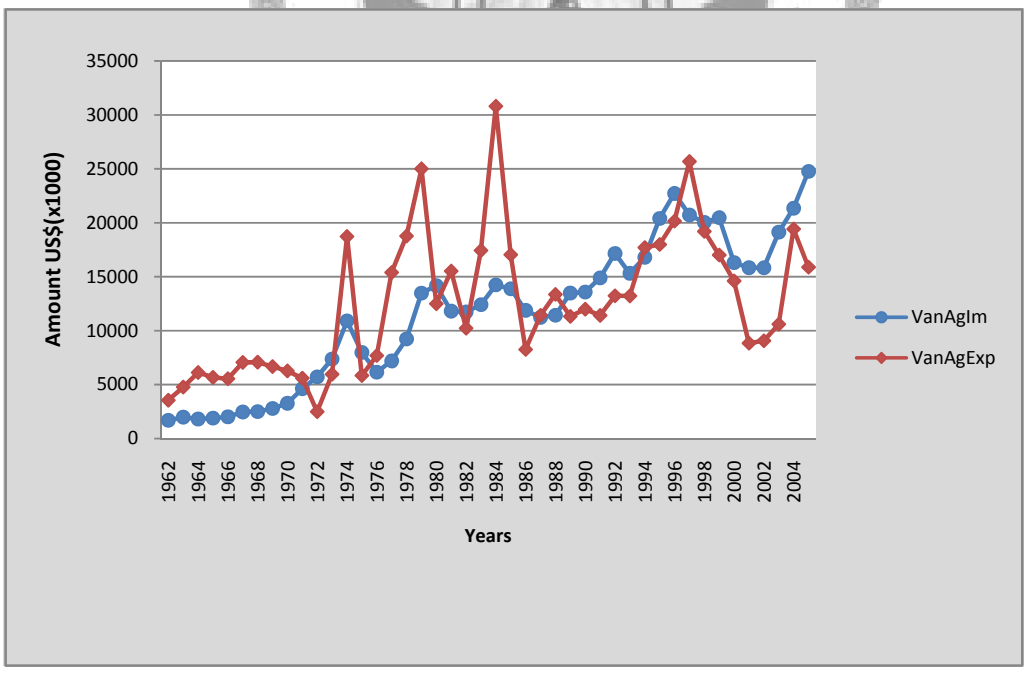
Source: FAOSTAT (2009)

Figure 1g Solomon Islands: Agriculture Export and Import (1962-2005)



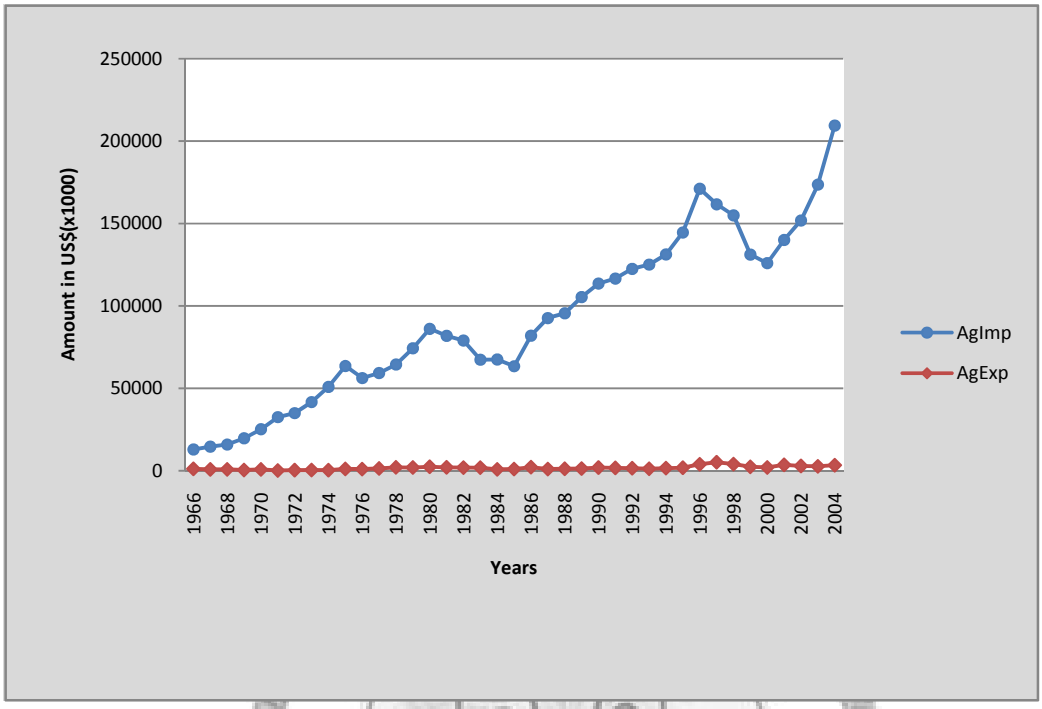
Source: FAOSTAT (2009)

Figure 1h Vanuatu: Agriculture Export and Import (1962-2005)



Source: FAOSTAT (2009)

Figure 1i New Caledonia: Agriculture Export and Import (1966-2005)



Source: FAOSTAT (2009)

Foreign aid received by Melanesian countries had been increasing over the years since 1966 with fewer impacts in the rural areas. Foreign aid if seen as a factor for agriculture development and growth, it should indicate positive trends in the agriculture sector of these countries. Despite the huge amount of foreign aid received by these countries, it does not have positive impacts in the rural areas of the Melanesian countries whose livelihood depends mainly on agriculture (Feeny, 2007 and Hughes, 2002) and as such, the agriculture sector did not gain much from various types of aid received. It is however important to note here that most foreign aid flowing into these countries must have been used in areas of no effect to the agriculture sector.

1.2 The Importance of Food Self-Sufficiency

Statistics on Melanesian countries have shown the agriculture sector is under threat and productivity will decline if proper policies and plans for self sufficiency in food production are not in place. Despite the declining percentage of people involved in agriculture, the decreasing agriculture contribution to the total GDP due to development and increased agricultural imports; agriculture sector will continue to remain important to these nations for the purpose of food self-sufficiency and security for the highly rural population. According to Lal et al. (1999), they pointed out that throughout the Melanesian countries, urban population is growing faster than the rural population so agriculture's relative significance in livelihood will diminish, though the function of agriculture in supporting large rural population will remain critically important for long time. The 70 – 85 percent of people living in the rural areas in most of the Melanesian countries added with increasing population growth rate, and people living below the poverty line; these countries will continue to depend on agriculture for livelihood, food security and income for the families and individuals.

Families need to be supported in their efforts to continue or return to their mixed crop farming activities in order to maintain the same level or higher production as in the past. In addition, traditional farming practices can provide a small, steady income for those who continue to plant and harvest traditional crops. Throughout Melanesia and the Pacific, food production activities (agriculture and fishing) continue to employ the greatest percentage of the labor force, either in commercial efforts, or more commonly, in self-sufficient endeavors (Ward, 1993) and as such, agriculture for food self-sufficiency is of paramount importance. Without food self-sufficiency policies in most island

countries, the recent global food crises had caused serious economic problems in their economies especially in food imports. Food self-sufficiency in the Melanesia will act as safety nets and cushion the impacts of such economic situations if it has to happen again in the future.

In addition to substituting local foods for imports, there are other efforts that can be done in the agriculture sector which can enhance the sustainability and self-sufficiency of the islands to have import substitution and reduce the over-reliance on agricultural food imports. The benefits of a movement to self-sufficiency and sustainability will reach beyond the obvious ones of increasing food security in the islands and maintaining viable land resources (Helu-Thaman, 1992). Involving local communities in the planning and implementation of measures to accomplish food sufficiency will strengthen these communities and their roles in the life of the islands to fight against food shortages and in the times of any global food crises.

Given the importance of increased agricultural productivity, there is a need for an analysis of the agricultural production efficiency that will give farmers the best possible input combination for efficient agricultural production. According to Idiong (2007), agricultural productivity can be raised either by adoption of improved production technologies or improvement in efficiency or both. However, with the low rate of adoption of technologies in the Melanesian countries, improved agricultural exports and slower improvement in the agricultural efficiency, proper strategic policy planning and implementation still remain options if agriculture productivity has to be carried forward.

As such, this study will be useful in providing valuable suggestions to proper policy and planning by decisions makers in forming strategic policies that would

effectively have positive impacts on the agricultural productivity growth in the Melanesian countries.

1.3 Objectives

The general aim of this study is to examine agricultural efficiency and productivity growth of the Melanesian countries. Basically it examines the influence of three inputs (labor, arable land and machines) on two outputs (crop and livestock) productivity in these countries agriculture sector. Independent variable determinants are also used to compare and analyze their effects on the TFP change of each country

The objectives of the research therefore include:

- To calculate the Malmquist Total factor productivity (TFP) change of the Melanesian countries;
- To examine the Malmquist TFP index for the five countries;
- To examine the factors influencing TFP changes over the study period and
- To examine the sources of TFP changes and test for their significance.

The thesis is organized into chapters. Chapter two provides the background and overview of the socio-economic characteristics and agricultural situations of the four Melanesian countries while chapter three outlines some facts in the review of the relevant literatures. Chapter four presents the methodology of the models and data used. Chapter five focused on the empirical results and provides brief discussions and summaries of the dependent and independent variables used in the analysis while chapter six will focus on the conclusions, implications and recommendations of the research.

Chapter 2.0 Overview of the Melanesian Countries

The Melanesian countries have similar socio-economic situations and problems, geographical settings, social and cultural background, political climate, technological growth, and agricultural related problems that may be unique from other developing countries in the world. Some of the unique problems that exist in these countries need to be solved in a way appropriate within their context and means of resources and technological innovations available to them. The similar issues and problems that are common to these countries are the main contributing factors to their agricultural productivity over the four decades of 1961 to 2005.

2.1 Country General Statistics

Fiji

Fiji has a total of 332 islands with a land size of 18,270 km^2 and 10.95 percent of the total land is arable; however 88 percent of the total land is under traditional land tenure system. Fiji became independent in 1970 after nearly a century as a British colony and has a total population of 931,741habitants with 48 percent live in the rural areas (CIA World Fact Book, 2009). The per capita GDP enjoyed by the people of this country is 3,900 US dollars. Labor force by occupation in agriculture is 70 percent; however it has an unemployment rate of 7.9 percent (1999) and its population below poverty line is 25.5 percent (FY 90/91) of the total population. The major agriculture products are sugarcane, coconuts, cassava, rice, sweet potatoes, bananas; cattle, pigs, horses, goats and fish. Fiji's agriculture exports consist of sugar, timber, fish, molasses and coconut oil.

Papua New Guinea

According to 2009 estimates (CIA World Fact Book, 2009), Papua New Guinea has total population of 6.057 million habitants with a GDP per capita of 2,200 US dollars. It has 87.4 percent of the total population living in the rural areas in some of the 151 remote islands. Papua New Guinea's huge land mass of 452,860 km^2 with 0.49 percent of the total land arable for agriculture production; however 97 percent of the total land is under customary or traditional land tenure system. Labor force by occupation in agriculture is 75 percent with an unemployment rate of 1.9 percent however; its population below poverty line is 37 percent of the total population. Papua New Guinea's major agriculture products include coffee, cocoa, copra, palm kernels, tea, sugar, rubber, sweet potatoes, fruit, vegetables, vanilla; shell fish, poultry and pork while its agriculture export commodities include , logs, palm oil, coffee, cocoa, coconut products, crayfish and prawns.

Solomon Islands

Solomon Islands has a total population of 595,613 (2009 estimates) and 82.7 percent of the total habitants live in the rural areas whom all enjoy a per capita GDP of 1,900 US dollars. With a total of 992 islands in the archipelago, the total land size of 27,540km^2 has 0.62 percent arable and suitable for agriculture production. As a multicultural country, more than 120 indigenous languages are used and local habitants owns 88 percent of the total land under the traditional land tenure system. Labor force by occupation in agriculture is 75 percent and major agriculture products are cocoa beans, coconuts, palm kernels, rice, potatoes, vegetables, fruit; timber; cattle, pigs and fish. Its major agriculture export commodities include timber, copra, palm oil and cocoa.

Vanuatu

In the archipelago of Vanuatu, it has over 80 islands with a population of Population 218,519 (2009 estimates) of which 76.1 percent lives in the rural areas (WBData, 2008). Compared with other neighboring Melanesian countries, Vanuatu has the least land size of 12,200 km^2 with 1.64 percent arable land suitable for agriculture (CIA World Fact Book, 2009). With 98 percent of the land is under traditional land tenure system, indigenous people of the country who are land owners are yet to fully utilize their land for agriculture development. It has the second highest GDP per capita of 4,600 US dollars in the region with a labor force by occupation in agriculture sector of 65 percent. Despite its unemployment rate 1.7 percent this Melanesian island economy is based primarily on small-scale agriculture, which provides a living for over 70% of the population. Its major agriculture products includes copra, coconuts, cocoa, coffee, taro, yams, fruits, vegetables; beef and fish however, its agriculture export commodities is confined to copra, beef, cocoa, timber, kava and coffee.

New Caledonia

With only 9 islands, New Caledonia has a total land size of 19,060 km^2 with 0.32 percent of the total land is arable for agricultural purposes. This high urban Melanesian country has a total population of 227,346 habitants with 35 percent of the total population live in the rural areas and enjoys a per capita GDP of 15,000 US dollar (CIA World Fact Book, 2009). Being more developed compared to other Melanesian neighbors the agriculture contribution to the total GDP in 2003 was 15 percent and labor force by occupation in agriculture was 20 percent with an unemployment rate of 17.1 percent

Major agriculture commodities are vegetables; beef, deer, other livestock products and fish, however agriculture exports are very minimal only with fish.

2.2 Smallness and Remoteness of Islands

Remote and isolated from (Refer figure 2a) the urban centers, services from the national government are almost unrecognizable on some of the remote islands. Difficulties with transport added with no communication linkages and poor or no infrastructure on the islands, agriculture productivity and rural development is difficult to be achieved in the rural areas.

Figure 2a The Map of Melanesian Countries

Source: http://www.nationsonline.org/oneworld/map/melanesia_map.htm

Geographically, Melanesian island countries are small in size thus played a decisive role in retarding the general economic performance. Added with smallness and

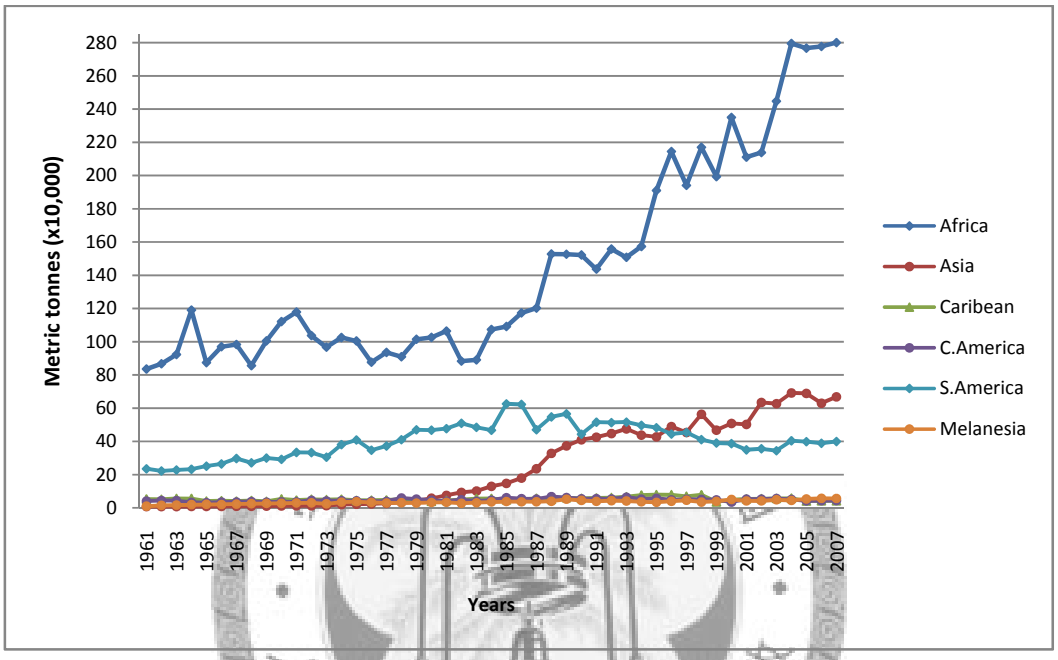
dispersed fragmentation of the islands, progress is slow in reducing the costs of production inputs and prices of consumption goods and services paid by farmers when the progress in the general development of the countries are slow. These countries tend to have higher production and marketing costs than many other developing countries in the argument of infrequent and unreliable sea transport. Smallness of size and the relatively high standards of living also makes the reservation price of labor high (Fleming, 2005). The archipelagic nature of these five countries creates further segmentation to the domestic markets hence they are not suitable springboards to the development of an export industry. This segmentation imposes further barriers to agricultural development to these economies when internal transport costs are high.

2.3 The International Competitiveness in Agriculture

Melanesian countries are faced with trade and export market difficulties due to their smallness, long distance from the rest of the developed countries and their slow progress in the global technology. Growth prospects in the Melanesian countries lie on few sectors and agriculture is one of them (Reddy, 2007). However, competitiveness in the global market, Melanesian countries do not have much influence in the marketing of agriculture products and it remains to suppress the agriculture sector to progress in this part of the world. Looking at the major commodities that rural population depends on them for generating income, their production capabilities is very small compared to the rest of other regions in the world (Refer to figures 2b, 2c & 2d). Copra, sugar, palm oil and cocoa production that these countries rely on as major exports for economic development could not compete with the rest of the world due to the small quantities produced by each country. Despite the Melanesian Spearhead Group as an organization to

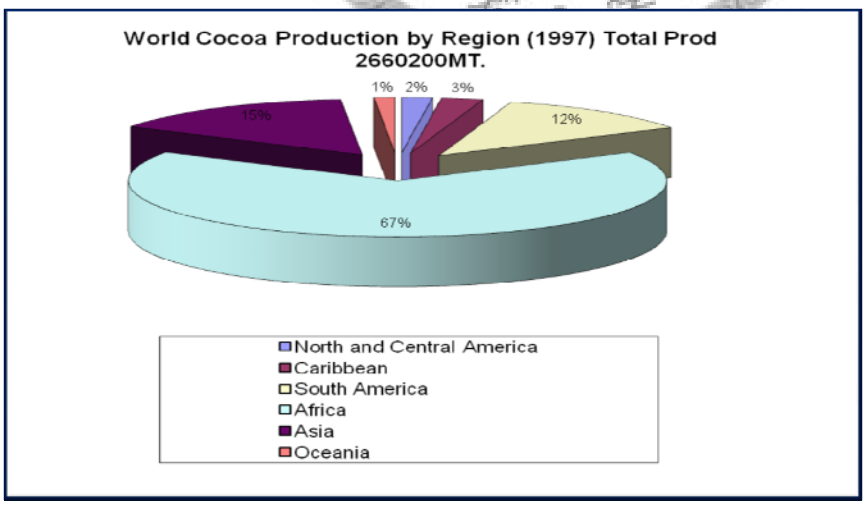
influence Melanesian trade with other countries and within the region has not been effective to compete vigorously with other developing countries in terms of export.

Figure 2b Cocoa Producing Regions of the World (1962-2007)



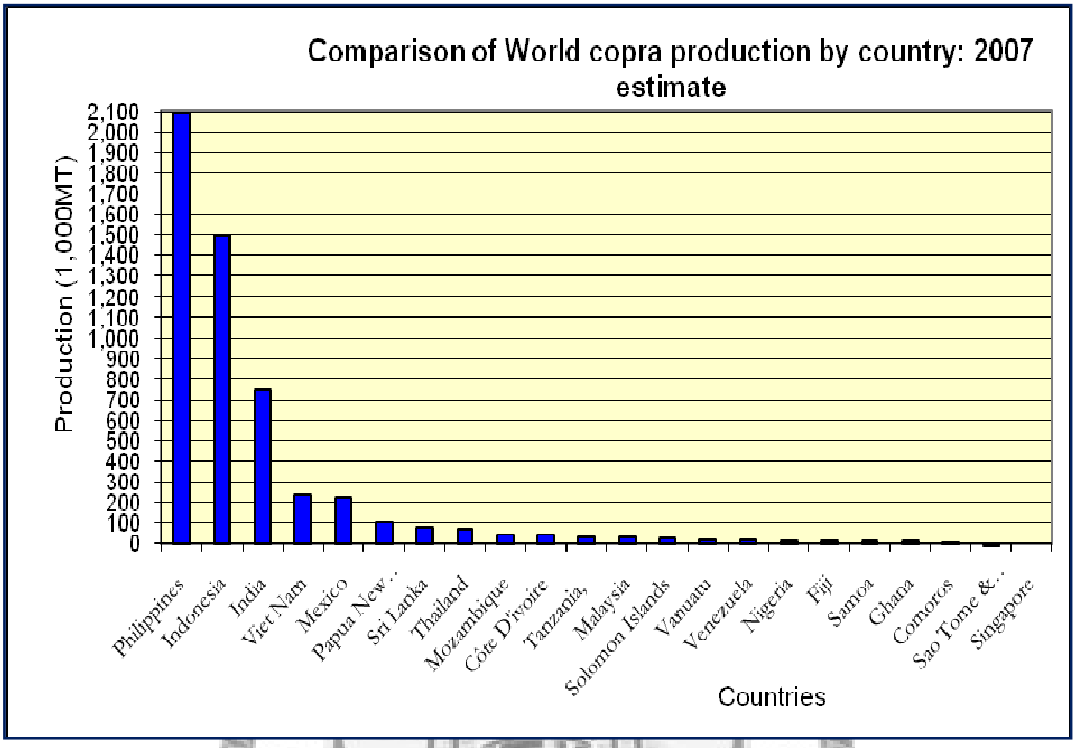
Source: FAOSTAT (2009)

Figure 2c Percentage share of the World Cocoa Production by Region (1997)



Source: http://www.oardc.ohio-state.edu/cocoa/regions.htm

Figure 2d Comparison of World Copra Production by Country (2007 Estimates)



Source: United States Department of Agriculture (2008)

The Melanesian region being located relatively far from the world markets, combined with their small export volumes, will not cope with high external transport costs per unit of export. It has long been considered that the constraint imposed by remoteness has put these countries in a relative disadvantage to compete with other regions in the world.

2.4 International Trade

The Melanesian Spearhead Group (MSG) is an organization established by the Melanesian countries to foster trade between the members. MSG Trade Agreement is a sub-regional trade agreement eliminating tariffs on trade. The initial members are Papua New Guinea, Solomon Islands and Vanuatu who initiated the idea in 1988 and

established in 1993. Fiji becomes a member in 1998 while New Caledonia started as an observer and finally become a full member in 2001. As least developed countries, they also enjoy certain preferential treatments with the larger and developed economies, including the European Union (EU). Melanesian countries, along with other Pacific Island countries are currently jointly negotiating an Economic Partnership Agreement with the EU. Despite been members of the organization for trade, export of agricultural products within Melanesian countries is yet to be fully realized by some of its members.

2.5 Exports and Barriers

Melanesian countries' economies are relatively open and are faced with many inherent constraints in diversifying their agricultural exports. These include a scarcity of domestic resources, acute shortages of skilled manpower, a lack of adequate economic infrastructure, geographical isolation from main trading partners and higher transportation costs (Gibson, 2006).

Rising import prices have contributed to the adverse terms of trade of most Melanesian economies from the early 1980s and added with natural disasters, these countries did not manage to drive forward in the agriculture sector. According to Fleming, (2005), Fiji, Solomon Islands and Vanuatu have experienced several cyclones in the 1980s that extensively damaged their infrastructure and destroyed several perennial export crops and livestock.

Trade barrier (quarantine, sanitary and phyto-sanitary) measures enforced by developed and other developing countries are making exports of raw agricultural products difficult for Melanesian countries. Quarantine requirements and standards for agricultural exports around the world are high, agricultural products from this region is barely for

domestic market. Lack of technology for processing and manufacturing in these countries further suppresses their competitiveness in the global market.

2.6 Small Population

Another obstacle to the attainment of cost reductions is the small population base of these countries. Gibson (2006) reported that population has a significant and positive impact on economic growth. He argues that small population can lead to small domestic markets and difficulties in achieving critical mass, scale economies and agglomeration economies. Small population further constrains the development of international trade and investment flows and costs of services provided by the private sector and public utilities to agricultural producers are high by international standards when exporting. With this scenario, rural subsistence farmers are faced with serious domestic marketing problems when their customers from the formal employment sectors are relatively low. As such, agricultural productions in the rural areas are merely focused for home consumption rather than production to earn an income.

2.7 Highly Rural with Subsistence Agriculture

Most Melanesian countries are rural based except for Fiji and New Caledonia with the fact that most people in these two countries live in the urban centers. Rural populations in these countries are the backbone to the production of food for home consumption and livelihood (Reddy, 2007). Production of food in the rural based concept may not be directly related with the economic development of a country but rather for home consumption and survival.

For village producers, production of copra and cocoa are still an important source of cash income to meet other family needs and social obligations. Despite the two

commodities are major sources of export income, coconut products have steadily declining since the 1970s due to old palm trees have not been replaced and old plantations have left idle due to low market prices. Exports of agricultural products have traditionally come from the larger commercial operations in palm oil, copra, coconut oil and cocoa.

2.8 Food Security

The United Nations Food and Agriculture Organization (FAO) warned that climate change-related disasters such as cyclones, flash floods and droughts are likely to have a serious impact on food production in Pacific island nations, and called for urgent measures to adapt to expected losses. A new report on climate change and food security in Pacific island countries (PIC), notes that development efforts in the islands have been seriously constrained by such disasters.

Overall food production has been able to keep pace with rapid population growth, through considerable intensification of land use. There are exceptions in areas of difficult or vulnerable physical environments (for example, low atoll islands) or when population pressure on land is high and new difficulties have emerged (declining fertility, increased pest and disease incidence). Logging has also reduced the availability of suitable land for food gardens in some locations, creating concerns about future food security in those areas. These impacts have higher risks to the agriculture productivity in the Melanesian countries.

2.9 Environmental and Pest Problems

The Melanesian countries are situated in the region that is highly vulnerable to tropical cyclones, hurricanes, earth quakes, volcanoes and tsunami. As such, it is critical

for these countries to build resilience of food systems to avoid enormous future economic losses in agriculture. There is a need to assess how vulnerable their food systems are and how they can adapt agriculture to future climate-related disasters.

Melanesian countries have less information on climate change. Farmers do not have access to information and guidelines on the choice of crop varieties, soil and water management options under changed environmental conditions to avert the risk of crop failures.

Sea level rise is one of the major problems that are faced by many pacific island countries, especially the low atoll islands in the Melanesian countries. This has adverse effects on agriculture food production and in few years time some islands will disappear from the world. Agricultural systems are particularly prone to damage, yet they are surprisingly resilient to natural disasters. Like in the Solomon Islands, cyclone Namu temporarily damaged the oil palm industry in 1986 and the rice industry was also destroyed.

In the tropical regions where the Melanesian countries are situated, climatic conditions are favorable to disease and pest infestations to crops. In this part of the world, weather is consistent throughout the year hence a pest outbreak is inevitable. Unlike countries with four seasons, a new weather pattern stops the same pest from continuing to destroy agricultural crops in a next new season.

2.10 Poor Infrastructure

The dispersed isolated island nature of these countries makes it difficult to have proper infrastructures such as roads, telecommunications and efficient shipping services. Basic services to some of the remote islands are always not fully met. Some of the larger

and economical islands still faced with poor road system, bridges and wharves. Such a situation further suppresses agriculture growth and development in the rural areas. Lack of effective rural infrastructure had increased hence great difficulties are faced by farmers in sending their products to the domestic market (Fleming, 2007). One of the negative factors for the farmers is with less than 30 percents of the population in most Melanesian countries are in the formal employment, agriculture produce from the rural areas usually does not end up in the domestic market. Efficient rural road system to allow effective transportation of goods to link with marketing centers may still be seen as ineffective to these countries when domestic market is still facing saturation. With more than 70 percent rural population are in the subsistence agriculture, transporting farm produce to the domestic market is not a viable avenue for income but is a costly exercise.

2.11 Agricultural Services

Hindered with poor infrastructure, dispersed remote islands and low funding towards agriculture sector, agriculture extension and services is almost ignored in some countries. In the Solomon Islands for example, agriculture extension services and programs from the Department of Agriculture and Livestock are not reliable and ineffective. As such, farmers are left in isolation to the latest developments in agriculture such as improved farming practices, sharing of new ideas and adoption to new technologies (Fleming, 2007). According to Fleming (2007), extension programs bring farmers closer to higher production whereas, research activities are more concerned with lifting the frontier. Extension services can only be improved in these countries if funding continues to come from donor partners. Efficient extension services with workable policies will drive the agriculture sector forward in this region. Remoteness of islands is

always the major hindrance to poor services and giving right information to farmers is always a problem in the Melanesian countries since most famers are illiterate. Agricultural services and programs in some of the island countries in Melanesia are generally poor.

2.12 Lack of Financial Services in Rural Areas

Most subsistence farmers that live in remote rural areas from urban centers are unable to have access to bank loans and savings. Loans and credits from banks are charged with very high interest rates while savings have very low interest rates. In the Solomon Islands, interest rates from commercial banks on loans can be high as 10 to 15 percent while savings interest rates can be very low as 0.5 percent. Studies have shown that affordable rural credit is important for the adoption to new technologies and entry into high value-adding industries but is not evident in all rural areas of the Melanesian countries (Fleming, 2007). Land cannot be used as collateral as in developed countries to support credits. Land tenure system is the major setback for farmers to access credit from banks to improve their farms. This problem has been caused by an absence of an effective leasehold title system however; agricultural credit should not be isolated from the more general concern about the need to provide effective financial services in rural areas. The more limiting constraint is the ability of borrowers to apply for and service loans. Subsistence farmers fear the risk of repaying loans due to the lack of market for their produce and with less management knowledge and skills they have.

2.13 Foreign Aid Dependency

According to Hughes (2002), she claimed that since 1970, AUD$100 billion has gone to the Pacific in aid and Australia has been the largest donor yet growth and

development in the Melanesian countries have not resulted positively. Foreign Aid is however, is not the solution to Pacific development, but a major part of the problem to political and socio-economic situations faced now by these countries. The Melanesian countries are well known for its aid dependency since they gained independence and the effect of foreign aid is yet to have some impact in the rural areas. Feeny (2007) claims a number of reasons why evaluating aid effectiveness in Melanesia should focus on the rural sector. According to Feeny (2007), these countries have received some of the highest levels of per capita in the world. Foreign aid contributes to about 14 percent of the total GDP in the Melanesian countries but growth the rural areas are very slow.

One of the questions that one can pause is on the use and distribution of foreign aid in these countries by sector basis. Solomon Islands foreign aid is mainly used in the education, health and recently, security (law and order) sector and small portion is used in agriculture and or in improving the infrastructure. Papua New Guinea is no exception and large amount of aid is used on security with law and order. Vanuatu and Fiji's foreign aid received is used more in education and health.

2.14 Issues of Land Tenure System

Restrictive use of land associated with communal ownership in the Melanesian countries is a stumbling block to rural development and this explains the slow growth of agriculture and hence low standards of living in the countries. In Melanesian countries there are basically three systems of land tenure; the customary, public and freehold. According to Larmour (2002) and the Commonwealth Australia Report (2008) on customary land tenure system (CLTS), Melanesian countries have high percentage of customary land owned by the indigenous people. Papua New Guinea and Vanuatu's total

customary land area are 97 and 98 percent respectively. Fiji has 88 percent of its land under Customary Land Tenure System while Solomon Islands have 87 percent of the total land under traditional land tenure system. New Caledonia under French leadership, land tenure system is controlled more by the government yet the legal system recognizes the reserved lands as belonging to the indigenous people inherited by clan.

Lands are traditionally owned by the indigenous people of these countries by tribal groups or clans that were handed down from generation to generation. The current western law practiced by the Melanesian countries recognizes the Traditional or CLTS yet almost 100 percent of these lands are not registered with titles for legal usage by all its members. However, it forms a fundamental phenomenon to all citizens of these countries that they own land and their livelihood are deeply rooted to the land. This is why land is seen as a major setback to agriculture development in most of these countries.

Customary land tenure has long been treated by development assistance agencies solely as an impediment to economic progress (Graham, 2006). Land in Melanesia is therefore not a factor to agriculture productivity since it has some rooted complexity with land issues and culture that surrounds land as an entity to produce food for livelihood. Land in Melanesia is integral to the workings of social cohesion, food security, cultural production and ecological management for future generations.

Through history and before Europeans arrived in the Melanesian Islands, land tenure rights did not have monetary value and evidence indicates that sale of these rights did not usually occur. In Melanesian culture, it is with land that one defines his identity and maintains his spiritual strength. Traditional land owners can allow others to use their land but they always retain the right of ownership. This view was not shared by people

outside of this culture who valued resources including land for what they can produce out of it rather for Melanesians it symbolizes many cultural values.

The ownership pattern formed the basis of social relationships and offered considerable security, protection and equity in access to resources within the group to their land. Land is seen by others with perceptions that land is a resources or commodities that could be traded in the market place. Land to Melanesians is a philosophical and spiritual item that needs to be looked after for the next generations to come (Boydell, 2001) and owners of the land are seen as land-keepers of the ancestors.

In the Melanesian culture, there is a deep-rooted belief in the stewardship of the land that is practiced up to today. The current generation has a responsibility in respect of the land that relates to the spirits of their ancestors along with the expectations of their descendants, in addition to the current generation. Descendants, as future members of the tribe are regarded as having the same rights of access to land as those tribe members that are currently alive. Land is free for the use of current tribe members on the basis that it will be passed on, without degradation, for the use of future members.

Determining the ownership and use of customary land is a very difficult and sensitive matter. It involves many social, political, economic, and spiritual issues. Land is a complex issue, to many, land is not a quantifiable entity rather, and land is a reflection of a human cosmic and genealogical relationship with a set of social beings (Narokabi, 1981).

Fleming (2007) argued that suitability of a communal land tenure system for generating agricultural productivity is a controversial institutional issue in most Pacific island countries and land tenure system has frequently been blamed for the inadequate

use of existing land resources. However, neglecting the values of the cultures on land, very few will become landlords that will further divide the wealthiest and poorest within these nations to further ethnic unrests and bloodsheds.

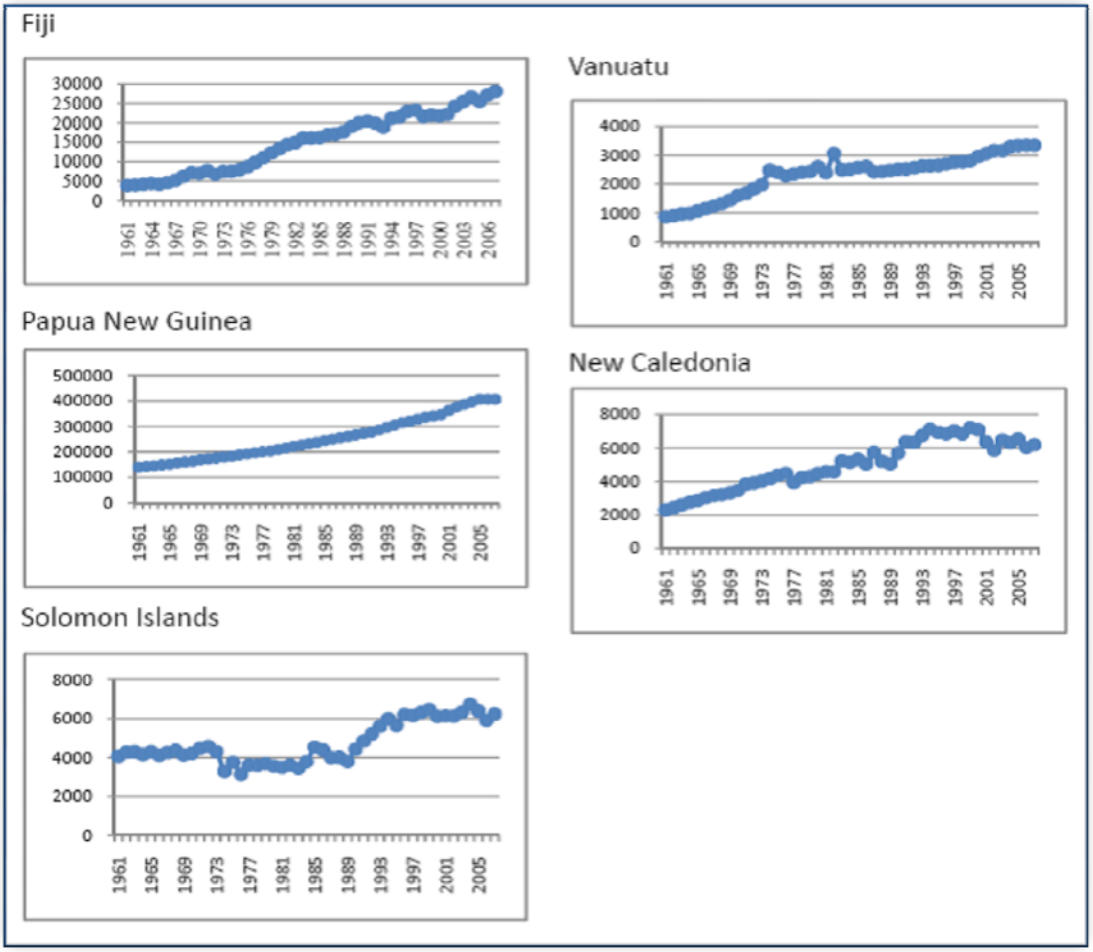
2. 15 Importance of Livestock and Crops

Culturally, the importance of livestock, cash crops and root crops to the Melanesian society is immense. Pigs are important to Papua New Guinea, Solomon Islands, Vanuatu and Fiji in a lot of ways, from normal meals to feastings and income to cultural political rank. Root crops are used in feasts, cultural ceremonies, marriages and barter system that still exist in the rural areas. Miles (2000) states that in most of the indigenous, small-scale communities which comprised traditional Vanuatu society, pig ownership and pig killing conveyed status, wealth, and informal power. Such rituals were the sole measure of social standing and political rank. Miles (2000) said that pigs are killed on ceremonial occasions and pig meat is distributed to everyone participating in the ceremony. Apart from cultural significance, these countries are self-sufficient in pig production; however imports of livestock products are mainly of canned meat products, sheep and other livestock not raised or farmed in the region. Vanuatu and New Caledonia exports cattle to other parts of the world while Papua New Guinea and Fiji are more self-reliant with locally raised livestock.

The staples of most Melanesian diets are root crops, such as taro, yams, cassava, and sweet potatoes and many also breed pigs and each family in the rural areas raises five to ten with local and exotic chickens. Locally produced livestock and crops are important to the diet and nutrition of the inhabitants of these countries while coastal people supplement their diet with fish. Despite fluctuations in the total crop productions in

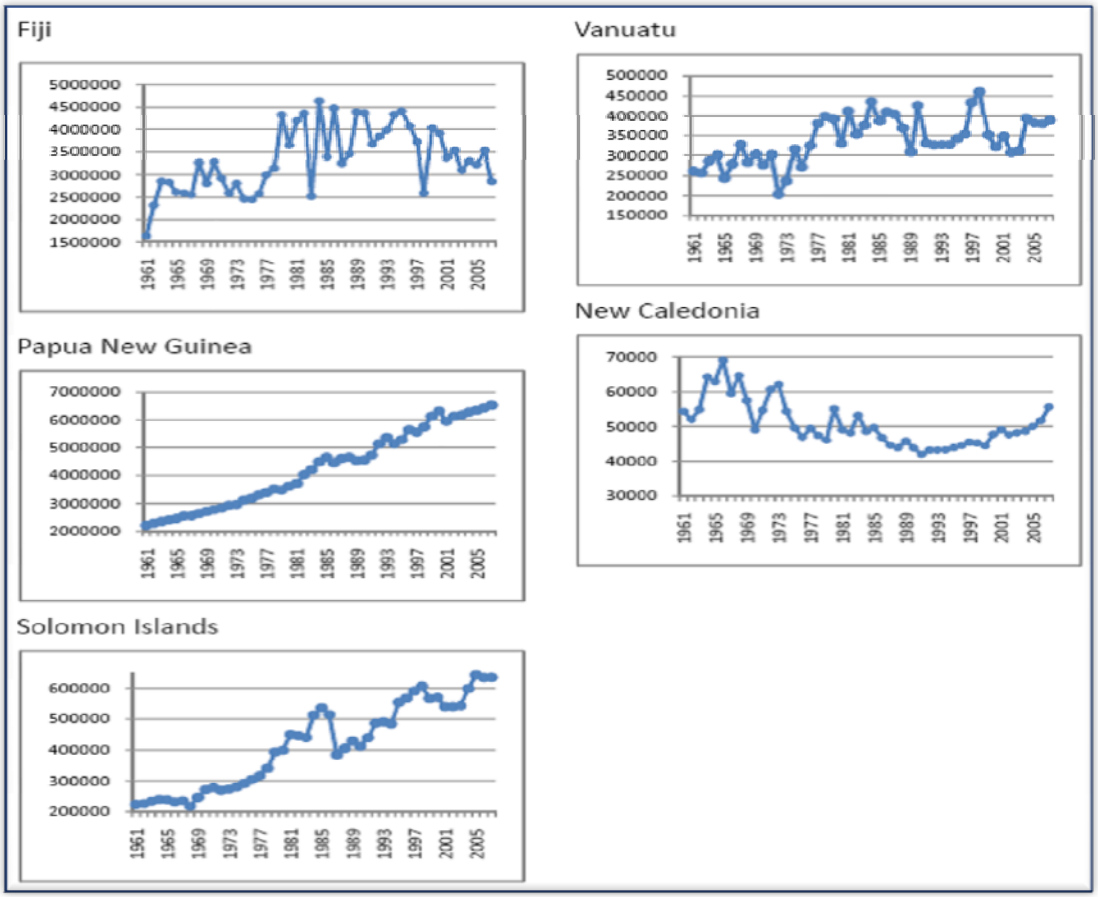
metric tons (MT) over the four decades for Melanesian countries, livestock total productions (MT) has been steady hence this also gives how important livestock is to the region. Figure 2e and 2f shows the total productions of livestock and crops in MT from 1961 to 2007.

Figure 2e Melanesian Countries Total Meat Productions (MT)



Source: Extracted from FAOSTAT, (2009)

Figure 2f Melanesian Total Primary Crop Productions (MT)



Source: Extracted from FAOSTAT, (2009)

Chapter 3.0 Literature Review

Efficiency and agriculture productivity growth has been a major topic of discussion amongst scholars, specifically in many least developing countries. Studies have been contacted in the past to analyze efficiency of the agriculture sector using various models of productivity in determining variables that contributed to the overall agricultural productivity of many countries.

3.1 Past Research

Few studies done in the Pacific region on agriculture TFP change have shown that agriculture productivity has been declining over the past years. Fleming (2007) study on agricultural productivity on five Pacific Island countries (Fiji, Papua New Guinea, Solomon Islands, Vanuatu and Tonga) shows that none of the countries studied had achieve significant TFP growth over the study period of 1970 - 2002. Using Malmquist DEA index on one multiple factor productivity measure and two partial productivity measures (labor and land productivity), the study shows there was no significant TFP trend in four of the Melanesian countries studied including Tonga.

Reddy (2007) results on similar study in the Pacific show a same trend. By using stochastic production frontier function on one output (agricultural production Indices) and four inputs (land area under cultivation, value of fertilizer, machinery – tractor numbers and labor), the study shows that, while production in the crop and livestock sector has increased in the Pacific, the per capita production has decreased. Moreover, the estimates of the total factor productivity reveal that there is very little gain for these countries over the past four decades (1961 – 2004) and efficiency has declined in all countries.

Foreign Aid as one of the main contributor to the total GDP in Melanesian countries, Feeny (2007) found that there is no correlation between growth in the rural areas and foreign aid. In using econometric analysis on data from 1980 – 2001, Melanesian countries results shows that aid has no impact on the agriculture sector in the rural areas. He stated that despite some huge amounts of aid in the 1980's to Melanesian countries (14 percent of the total GDP), rural agriculture sector still remains stagnant. He concluded that despite no evidence of the impact of aid, there are some signs in the economic growth.

Similar evidence of declining agriculture productivity as in the Melanesian countries was also found in some of the developing countries around the world. The study done by Fulginiti et al. (1998), on changes in agricultural productivity in 18 developing countries over the period 1961-1985 shows declining TFP change. They use a nonparametric, output-based Malmquist index with a parametric variable coefficients Cobb-Douglas production function and their results confirm with previous findings, that half of the countries studied had experienced productivity declines in agriculture. By using aggregate agricultural output with land, labor, fertilizer, machinery and livestock their result shows that fertilizer and machinery are major contributors to output growth and countries that tax agriculture heavily had the most negative rates of productivity change.

The developing countries of the Caribbean region also show similar results as to those studied in the Pacific. Using Malmquist indexes of multifactor productivity in the agriculture sector, six countries where studied from 1961 -1991. In this study, Hutchinson et al. (1999) found that on TFP growth there is a decline in agricultural productivity over

the study period. Hutshinson et al. (1999) also found that some of the countries, the decline in productivity may be small but they represent an average annual change that indicate over a 30 year period, countries with an average decline of 0.7 percent will have a cumulative fall by 21 percent in their productivity.

Chavas in Zepeda (2001) study in 12 countries with differences in agro-climatic conditions, human capital and infrastructure appear to contribute to a spread in agricultural productivity across countries. Chavas focused on agricultural technology by using two outputs (crops and livestock) and four inputs (land, labor, machinery and fertilizer) during 1960 – 1994. By using econometric and non-parametric approach, Chavas's results indicate that agricultural technical change and productivity growth across countries are weak. However, the declining or no change in the agriculture productivity in many countries might have been hindered by inter-related determinant factors.

In the African region, Wiebe et al. in Zepeda (2001) found that agriculture in Sub-Saharan Africa (SSA) productivity is hindered by different kinds of constraints. These constraints include poverty, poor infrastructure, political instability and limited use to conventional inputs. Wiebe et al. also states that other important constraints in SSA include quality and unavailability to education, poor research and extension services, as well as institutional uncertainly. They also found that agriculture performance in SSA countries is a mixed based and TFP in agriculture has grown by an average of 1.3 percent annually between 1961 and 1991. On the same context Land Productivity in SSA agriculture had rose by an average of 1.9 percent between 1980 to mid 1990's and labor productivity fell by an average of one percent with fertilizer applications have also

decline by 1.1 percent a year since 1990. The study suggests that to improve productivity in many SSA countries, it should be through increased use of conventional inputs, fertilizer, physical capital and livestock.

Based on further determinant factors on agricultural productivity, Ajao et al. (2003) study on changes in agricultural productivity in SSA countries found that government effectiveness was not significant. In their study they use DEA to measure Malmquist indexes of TFP and further examine the effect of land quality, malaria, education, and selected governance indicators such as control of corruption; they found all variables to be significant. With TFP, they also found that education and land quality index had an inverse relationship.

Policies as a determinant factor to agriculture productivity were also used in some African countries TFP studies. Impact of agricultural policies and investment on productivity in Zimbabwe and South Africa showed yield differences between commercial and communal areas and reflects market differences in the access to input and output markets, land quality and climate (Wiebe et al. in Zepeda, 2001). They found that poor infrastructure also results in high transaction costs thus reducing the ability of farmers to compete in both the input and output markets. Wiebe et al (in Zepeda, 2001) also identified the major constraint is the need to increase investment in agriculture research to improve productivity growth and increase the stability of regional food production and prices in the region.

Nkamleu et al. (2003) also examine the economic performance of a large number of African countries using an international comparable data set of 16 countries over the period 1970–2001. Their study found TFP has experienced a positive trend in the

sampled countries. Their focus on growth in TFP and its decomposition into technical change and efficiency change components, good performance of the agricultural sector in these countries was due to good progress in efficiency rather than technical progress. Their study also highlights technical change to be the main constraint to achieve high levels of TFP with other institutional and agro-ecological factors.

Study on agricultural productivity and its determinants by Ortega et al. (2004), provide estimates of growth in agriculture's TFP for a panel of countries using translog-production functions. Their results shows evidence of international heterogeneity in agricultural TFP growth rates in most developing countries. Some of these developing countries have positive rates during 1960 – 2000 than in some advanced countries. In the determinants of agricultural productivity, their evidence suggests that electricity has positive impact on TFP growth and surprisingly roads have negative effect on TFP growth in some countries. Among their findings, they also found that illiteracy tends to hamper productivity growth and positive temperature anomalies are damaging for TFP growth. This shows that some determinants of positive agricultural productivity growth in some countries are in fact hinders TFP growth in others.

Antle (1983) in another study of 47 least developed countries (LDC) and 19 developed countries using Cobb-Douglas production function model, found that infrastructure and agriculture research are significant to agriculture productivity, however, transportation and communication infrastructure is an important constraint on aggregate agricultural productivity in developing countries. Education does not contribute significantly to the model used and agricultural research explains less of the variation in agricultural production in LDC than infrastructure.

In Bangladesh, Randrianarisoa et al. (2001) found that education is an important determinant of agriculture productivity; however primary education has higher agricultural production by 8 percent compared to those with no education. Secondary education does not show a significant effect on agricultural production.

3.2 Research Methods

The Malmquist index has become popular around the world with its workable feature for allowing further decomposition of productivity variation (Luh et al. 2008). The Malmquist index is initially estimated for output data in 1990, and the approach was adopted by Coelli et al. (2005). This method is widely used to calculate total factor productivity change in many developing countries around the world. Regression analysis models have also been widely used together with Malmquist Indexes to analyze the relationship with independent variables as determinant factors to agriculture productivity. These two models are used by many scholars in research in many developing and least developed countries.

3.2.1 Malmquist Index

Amongst many scholars, Fleming (2007) use this model to measure farmers in agricultural sectors in five Pacific island countries by estimating agricultural productivity change over the period from 1970 to 2002. By using the Malmquist DEA model, the study showed none of the countries including some Melanesian countries achieve significant TFP growth over the study period.

Hutchinson et al. (1999), in their study of six Caribbean countries also uses the Malmquist index to calculate agriculture productivity growth in that region of the world and found some countries have decline in agricultural productivity. Fulginiti et al. (1998), study on changes in agricultural productivity in 18 developing countries over the period

1961-1985 also used the output-based Malmquist index. Their results confirm with previous findings, indicating that half of the countries studied have experienced productivity declines in agriculture.

Luh et al. (2008), use the Malmquist DEA technique in their study of the sources of agricultural growth for eight East Asian economies with special emphasis on international knowledge spillovers. Trueblood, et al. (2003) also use the malmquist index to examine agricultural productivity growth over the 1961-91 period for a sample of countries including the SSA region.

Some studies have had their focus solely on African economies' efficiency, productivity changes, and sources of productivity change. One of these studies was done by Ajao et al. (2003) who examined changes in agricultural productivity in SSA countries. Their study was in the context of diverse institutional arrangements and again by using DEA to measure Malmquist indexes of total factor productivity. Fulginiti et al. (1998), their paper that examines changes in agricultural productivity in 18 developing countries over the period 1961-1985 also use Malmquist index and their estimates confirm results from other studies that indicated declining agricultural productivity in LDCs.

Nkamleu et al. (2003) examine the economic performance of a large number of African countries using an international comparable data set of 16 countries over the period 1970–2001. Their analysis is also undertaken using the data envelopment analysis (DEA). By using DEA their results indicate that institutional factors as well as agro-ecological factors are important determinants of agricultural productivity growth.

3.2.2 Regression

Regression analysis is a statistical model commonly used in many research papers to determine the efficiency levels of each country where a linear regression model is

employed to identify determinants of production efficiency. The model assumes that the inefficiency effects are independently distributed having distribution and mean. In agricultural productivity study, it is used to confirm whether determinants of TFP change exists in cross country or region.

Luh et al. (2008) used regression model to regress variables including domestic research & development (R&D) and international spillovers to characterize the differential patterns of growth in eight Asian countries.

Burnside et al. (1997) also used data on foreign aid to examine the relationships among foreign aid, economic policies, and growth of per capita GDP in a panel growth regression for 56 developing countries in a six-four-year periods (1970-93) to find that policies have a great effect on growth and are related to fiscal surplus, inflation, and trade openness. Ajao et al. (2007) examined changes in agricultural productivity in SSA countries using regression analysis to find education and land quality index had an inverse relationship with TFP. Cornia (1985) also used regression analysis in the study of 15 developing countries on farm size, land yield and the agricultural production function focusing on the relationship between factor inputs, land yields and labor productivity for farms of different sizes. Antle (1983) use the same regression model to find the significance of infrastructure, education and research on total agricultural output in 47 least developed countries and 19 developed countries and Randrianarisoa, et al. (2001) also used regression model to analyze education as an independent variable to agricultural productivity in Bangladesh.

3.3 The determinant Factors

3.3.1 Foreign Aid

Kaya et al. (2008) defined foreign aid as “economic assistance provided to a country by another country or organization and It can be given for economic, political or humanitarian purposes and can be classified as loans and grants, bilateral and multilateral aid or tied and untied aid”.

Discussion of many literatures on foreign aid impacts are based more on economic growth rather than agriculture growth. However, since developing countries’ economies depend more on agriculture, any positive or negative economic growth resulting from foreign aid is assumed to be very closely related to agriculture sector.

Feeny (2007) study on the impact foreign aid to Melanesian countries concluded that aid has no impact on agriculture growth by using annual panel data for the period 1980 to 2001. With his study there is some extend to economic growth and without aid there will be no economic growth for these countries. He concluded that large amounts of foreign aid directed to the health and education sectors should have impacts on the rural sector in the long-run.

Pavlov et al. (2006) stated that foreign aid has contributed to growth with decreasing returns on productivity in developing countries. However, some studies found that there is only a positive relationship between aid and growth when there is a favorable policy environment. It is unclear whether these conclusions apply to the Pacific island countries given their unusual features with, small populations, remote locations and high level of aid dependency (Pavlov et al. 2006).

In Pavlov et al. (2006), their study was unable to provide an adequate explanation

for the role of institutions and policies in growth in the countries studied in the Pacific. They found that in PICs, support for infrastructure has tended to decline over recent decades as more resources have been directed to investment in human capital via the education and health systems which are reflected inter-sectoral biasness. Pavlov, et al. (2006) further explains that *"aid in Melanesia also seeks to support growth by building the institutional environment through institutional strengthening projects for government agencies or support programs for civil society neglecting direct impact to agricultural productivity"*. Their use of the model framework of Hansen and Trap (2000) on variables of income per capita, domestic savings, foreign aid and private capital, their results shows that there is significant positive relationship between economic growth and aid from all sources in the seven PICs studied, however they concluded that there are declining returns from aid.

Hughes (2002) came up with some remarks on why the Pacific has failed to develop and grow despite large amount of aid inflows received by the region. The study concluded that the failure of the economies to grow and develop is leading to the emergence of poverty and stagnant living standards. The study also pointed out that parliament and government bureaucracies unequal high shares of national income at the cost of the rest of the population is continuing and corruption is inevitable when politics become the major players of wealth. The study further emphasized that civil unrest in the Melanesian countries over the past years and land tenure problems have contributed to the failures of impact on foreign aid in the Melanesian countries.

Similar to Melanesian countries, foreign aid does not have positive impacts on some African countries. Mallick (2008) study in six poorest African Countries, examining

the effectiveness of foreign aid for economic growth found that, a long run relationship exist between per capita real GDP, aid as a percentage of GDP and investment as a percentage of GDP and openness. However, they found that the long run effect of aid on growth was negative in most of these countries.

Others have also concluded in their studies that there are positive impacts on foreign aid in other sectors of the economy. A study done by Burnside et al. (1997) examines the relationships among foreign aid, economic policies, and growth of per capita GDP in 56 developing countries. In panel growth regressions for six four-year periods (1970-93), they found that policies that have great effect on growth are those related to fiscal surplus, inflation, and trade openness. With some interactions, they find that aid has a positive impact on growth in developing countries with good fiscal, monetary, and trade policies. In the presence of poor policies, aid has no positive effect on growth. They also found that reallocation of aid would have a large positive effect on developing countries' growth rates.

An impact of foreign aid on agriculture sector in the developing countries was the recent study done by Kaya et al. (2008). In their study they found that there is a positive and statistically significant relationship between growth in the agricultural output and agricultural assistance for rural development. As such, foreign assistance given for developmental purposes can achieve its goal if aid is targeted for the agricultural sector of the developing countries.

Akatwijuka (2004) claimed that coordination failure in foreign aid had contributed to the failure of aid to have an impact on the economic or agriculture growth in the developing countries. The study find that the more similar preferences the donors

have, the more scope there is for the coordination failure. In most circumstances, aid is based on donor priority areas hence the lower priority sectors may not get enough funds as all donors concentrate too much on the priority sector which can result in overfunding, and over-sharing may occur. These types of coordination failure in foreign aid may have lead to less impact on the economic growth to occur in some developing countries if donors are not aware of such scenarios.

In terms of development priorities Kasuga (2008) examines whether donor's relative effort across sectors is associated with the recipient's relative need across sectors by estimating rank correlation coefficients. In this study, little evidence shows that donors concentrate their aid on high-priority sectors in each recipient country and as such, inter-sectoral allocation of aid flows reflects the recipient's need. On the other hand, there was also some evidence that shows countries with poor governance have extremely inefficient inter-sectoral allocation. Kasunga (2008) found other contrasting results of inter-sectoral allocation and inter-recipient allocation and that aid coordination among donors should focus more on alignment with the recipient's development priorities.

Another view discussed by Ali et al. (2006) on determinants of foreign aid is an important factor needed to be considered to why foreign aid continue to fail the well being of recipient developing countries. The relevant analytical question is not to assess whether aid is harmful or beneficial but why different countries receive different amounts of foreign aid. Ali et al. (2006) attempts to identify the determinants of foreign aid and examines the extent to which taxes on international trade and the scope of government activities, ethnicity, private credit, and education determine foreign aid. Using alterative equations their paper endogenizes government consumption, taxes on

trade, GDP per worker, and trade to capture their interrelationships. Ali et al. (2006) study on 151 countries over the period 1975 to 1998 found that taxes on trade increases foreign aid dependency with trade, private credit, foreign direct investment, GDP per worker, ethno linguistic fractionalization, and government consumption all found to be important determinants of foreign aid. If Aid is more focused into needed development areas, it can have some direct impact on the recipient countries.

3.3.2 Agricultural Exports

According to FAOSTAT (2009), Agriculture exports in the four Melanesian countries have been increasing over the four decades (1961 – 2005) with fluctuating trends except for New Caledonia it shows a stagnant horizontal trend. Increasing trends are encouraging for agriculture based countries however, in the recent years agriculture imports in this region have also been closing the gap with agriculture exports. These exports are envisaged that it would have contributed well towards agriculture productivity.

Fleming (1993) study provides a foundation for government agricultural development and marketing strategies used by agribusiness and marketing firms in the Pacific. The study stressed that "agribusiness firms in small developing countries face a special set of circumstances when formulating strategic marketing decisions" and with the nature of small economies firms must have a strong export foundation but with the little influence in the markets to which they export they cannot compete. Fleming (1993) also emphasized that effective agricultural export marketing strategies of agribusiness farms require successful formulation in the domestic and export sectors.

With trade barriers and restrictions, McGregor (2007) found that quarantine restrictions are major obstacles to agricultural exports from the Pacific island countries to

other countries. As such, there is a need for scientific and technical assistance for the promotion of agricultural exports from the region and allow the region to participate in the rapid global growth in trade in high value agricultural commodities. These small countries have the potentials but with limited technical capability, agriculture exports will continue to have a lot of obstacles to go through.

Borgatti (2008) study has some constructive arguments on problems faced by Pacific Island countries with exports. The study argued that bilateral trade of geographically distant countries is likely to be negatively affected by the distance separating them from their trading partners and positively affected by their remoteness. In the presence of competitive transport costs due to far distances, the effect of remoteness and distance is diluted. In an augmented gravity model applied to the Pacific islands' bilateral trade from 1980 to 2004, Borgatti, (2008) study shows that a doubling of the elasticity of distance would decrease their average bilateral trade by 80 percent and remoteness positively affects the Pacific islands' bilateral trade, but does not compensate for the negative effect of distance. Borgatti, (2008) found the opposite for the Caribbean islands, where the elasticity of trade with respect to remoteness is six times bigger than that for the Pacific islands. She concluded that the cluster analysis for 30 small island states (SIS) shows that the Pacific islands belong to the clusters with the weaker infrastructure stocks, leaving them with a large scope and room for improvement.

Kandiero et al. (2004) study on attempts to identify factors that constrain agricultural exports from SSA to the world market found that investment in infrastructure and access to information are important factors that determine Africa's agricultural exports with high and significant correlation between infrastructure and the use of

agricultural inputs and agricultural productivity, which on their own are significant determinants of agricultural exports. They concluded that for SSA countries to increase their share of agriculture in the world market, they have to undertake reforms that reduce macro distortion in their economies.

3.3.3 Agricultural Imports

Agriculture imports may have positive or negative impacts on agriculture productivity, however, there is less literature on whether importing of agriculture food has some impacts. In his study on food security in selected South Pacific Island countries at the national and household levels during the period 1991-2002, Sharma (2006) found that during recent years import dependency for food items has increased mainly due to a decline in per capita food production and a rapid rate of rural-urban migration. With the narrow resource base and production conditions, Pacific islands concentrate only on a few primary commodities for production and exports. He pointed out that currently, export earnings can finance food imports but earnings could fall short of the requirements needed after the expiry of some commodity preferential price agreements with importing countries. He concluded that import dependency for food in the Pacific had increased over 1991-2002, and with the increase of population and urbanization; the demand for imported food items will continue to increase in the future.

One of the major concerns of imports by developing countries such as the Melanesian countries is that they will remain as importers from developed countries if governments of these economies do not provide subsidies for farmers. The argument with WTO on the Doha round by Dimaranan (2004) is that long-term subsidies for agricultural programs in developed countries will leave the developing countries to increasingly

dependent on imports of these subsidized products from developed countries. As such, agriculture productivity in these developing countries will continue to decline in the years ahead.

Lopez et al. (1996) in their study they states that although imports alone have effect on domestic market by lowering domestic prices, the direction and strength of their impact on price cost margins depends on the interaction of economies of scale, conjectural variation, and demand elasticities. They concluded that the direct effect of imports in depressing domestic prices, the further impact on prices caused by the reactions of domestic producers, and the associated changes in costs. They also state that imports can have a positive or negative impact on domestic price cost margins depending on the sign and the strength of each of these elements and a positive effect is theoretically consistent with weak economies of scale and low elasticities of demand. Imports can have a negative impact on price cost margins, especially in markets characterized by strong economies of scale and high elasticities of demand.

Sharma et al. (2005) study in Tanzania and Senegal shows rapid growth in poultry imports and revealed the weaknesses of the domestic processing industry in competing with imported products, particularly in situations where there has been rapid growth in demand for further processed quality products which the local industry has failed to supply. It was found that imported products were primarily sold in cities, where the import shares were much higher and segmentation of urban and rural markets appears to be an important issue in assessing impact; it may be high in localized commercial markets, but much less in rural areas. They also said that this fact raises the issues concerning the competitiveness of domestic producers in supplying growing urban markets, and in

particular for further processed products.

There can be spillover effects on agriculture imports when it is associated with research and development (R&D) and foreign direct investment (FDI). Foreign R&D has the advantage that they might give stronger effects when imports account to a large percent (Luh et al. 2008). In addition to that, importation of agriculture inputs such as machines, seeds, commercial feeds, raw feed materials, fertilizers, animal drugs and pesticides can have positive impacts on agriculture productivity however; importation of only food and food products can have negative impacts on productivity when the same product can be produced by the importing country (Sharma et al. 2000). Such a situation will have significant negative impacts on agriculture productivity.

3.3.4 Trade Organization

The Melanesian Spearhead Group (MSG) is an organization established by the Melanesian countries to foster trade between the members and the Trade Agreement is a sub-regional trade agreement eliminating tariffs on trade (MSG TRADE AGREEMENT, 1988). Similar with the concept of free-trade, many trade organizations were established in regions around the world. The World Trade Organization (WTO) is made up of almost all countries in the world. On the regional scene we have the European Union (EU), North American Free Trade Agreement (NAFTA), Association of South East Asian Nations (ASEAN), Cooperation of Fair Trade in Africa (COFTA), Central America Free Trade Agreement (CAFTA) and Caribbean Community (CARICOM).

The regional trade organization can have a lot of benefits to its member countries in a lot of ways. For the ASEAN community, Plummer et al. (2007) states that the attraction of FDI inflows is an important goal that will also in large part determine the

success of ASEAN's integration efforts. They said that stimulating FDI inflows by reducing business costs associated with multinational activity in the region is a great benefit and FDI inflows have become paramount to an outward-looking development strategy in the contemporary global economy when capital flows, foreign exchange, easy access to foreign markets, and technology transfer will be on the rise. The similar benefits from FDI can also experienced by other trade regions around the world.

Anderson et al. (2001), their study confirms that substantial barriers to market access will remain in both rich and poor countries following full implementation of the Uruguay Round agreement. Their analysis finds that approximately 40 percent of the costs of these barriers to developing countries arise from barriers to market access in industrial countries and as such, countries engaging in regional trade organizations will not be very much affected by these costs. With the objectives of regional trade benefits, least and developing countries under their segmented regional trade agreements will benefit from each other from the comparative advantages each has in their own commodity production costs.

3.3.5 Natural Disasters

Natural disasters occur when extreme natural phenomena like earthquakes, floods, or storms cause loss of lives, human suffering, or extensive damage to property. An event qualifies as a disaster in the OFDA/CRED database (2009), if at least one of the following criteria is fulfilled: 10 or more people are reported killed; 100 or more people are reported affected, injured, and or homeless; the government declares a state of emergency; or the government requests international assistance.

Small islands have for some time been considered as being highly vulnerable to natural hazards (Lewis, 1979). According to Ellis (2008), climate change and agriculture

are perfectly linked. Agriculture sector still depends entirely on weather for its growth and development. Climate change has already caused a negative impact on agriculture in many parts of the world because of increasingly severe weather patterns in terms of tropical cyclones, floods and droughts. Ellis (2008) stressed that climate change is expected to continue to cause floods, worsen desertification and disrupt growing seasons. Climate change and food security are related because climate change can directly affect a country's ability to feed its people.

Campbell (2006) study shows cyclone Meli in Fiji (1979) destroyed 54 – 100 percent of the crops. In the Solomon Islands in 1986 (Trustrum et al. 1990) Cyclone Namu destroyed buildings, roads, bridges, crops and forests. Palm oil plantation production was affected with the only rice commercial farm in the country was totally destroyed.

Natural disasters are common in the Pacific island countries (Narayan , 2003). In his study of Fiji, cyclones exerted substantial damage to infrastructure, agricultural and industrial activity. By using general equilibrium model to examine the short-run macroeconomic impact, the key results are that, cyclones negatively impact private income, consumption, savings, real GDP and real national welfare. Income of rural population in the Melanesian countries depends on agriculture because of their highly rural based livelihood.

Mirza (2003) also highlighted that Islands are highly vulnerable to impacts of climate change on water supplies, agricultural productivity including exports of cash crops, coastal ecosystems, and tourism as an important source of foreign exchange for many islands. Data analyzed on Indian cyclones in 1971 to 1999 on the state of Orissa of

India shows more than 60 percent of agricultural crops and livestock were destroyed at each occurrence.

In the Caribbean region, Rasmussen (2004) study on macroeconomic implications of natural disasters in the Caribbean mentioned few similarities. On average, a natural disaster occurred once every four and half years in each of the six countries studied. Rasmussen (2004) stressed that among these large disasters, the median number of affected persons amounted to 9 percent of the country's population and the median value of damage was equivalent to 14 percent of the country's annual GDP and some events have been truly devastating, affecting the population of an entire country and causing damage exceeding 100 percent of annual GDP.

Lee (2004) in his study on the social protection and poverty reduction in the Caribbean found the most prevalent risks are hurricanes or tropical storms. In the Caribbean region, natural disasters usually have adverse effects on the economy because of the negative impacts on the banana crop. In Puerto Rico (Sanchez et al, 1995), flood associated with tropical cyclones and rain was reported to have very high costs as impacts during the years of occurrences in the Caribbean region.

In the SSA natural disaster types is quite different to that of the Pacific, Caribbean and India. The SSA countries are well known for the long spell of dry seasons (drought) which is opposite to the Island nations and this has adverse effects on agriculture productivity. According to one of the report produced by UNESCO, (2002), the region clearly makes up the core of the global drought and desertification problem. The report revealed that severe droughts in the 1980's and 1990's significantly reduced food production and disrupted national economies to such an extent that some 20 countries had

no alternative but to appeal for international support. Agriculture has remained the most important sector in the African economy, with 70 percent of agricultural output coming from small farmers.

Chapter 4.0 Methodology

The next section consists of the Malmquist DEA and Regression models, the research data and the procedures used in the analysis for results.

4.1 The Malmquist DEA Model

The Malmquist index is initially estimated for output data in 1990, following the approach adopted by Coelli et al, (2005). FAO production indices are then used to calculate crop output data for each year in each country back to 1961 to 2005. The data are used to construct Malmquist indexes to measure TFP changes in the agricultural productivity in each Melanesian country over the period.

The measuring of productivity and productivity change as a part of performance measurement usually achieved using index number approach but such total factor productivity (TFP) indices must satisfy certain properties. One such property is that if a country produces the same output quantities in both time periods (say periods *s* and *t*) but the input use is decreased by a proportion then the TFP index should increase accordingly.

The data used in the analysis is a time series data set of countries in periods given as *s* and *t,* and the Malmquist DEA approach was used mainly to determine the total factor productivity change in period *t*. Productivity change refers to movements in productivity performance of a country over time. According to Coelli et al (2005), the output-oriented Malmquist TFP index "measures the maximum level of outputs that can be produced using a given input vector and a given production technology relative to the observed level of outputs". It measures the radial distance of the observed output vectors in period *s* and *t* relative to a reference technology.

The model used in this calculation below is based on the Coelli et al (2005)

output-oriented Malmquist TFP index. The output-oriented Malmquist productivity change index between period *s* and *t* are respectively defined as:

$$m^s{}_o(y_s, x_s, y_t, x_t) = \frac{d^{s}{}_{o}(y_t, x_t)}{d^{s}{}_{o}(y_s, x_s)} \text{ and}$$

$$m^t{}_o(y_s, x_s, y_t, x_t) = \frac{d^{t}{}_{o}(y_t, x_t)}{d^{t}{}_{o}(y_s, x_s)}$$

The equations above show the minimal output-deflation factor, such that the deflated-output vector for the country in a particular time period and the input vector, x_t, are just on the production surface of the technology in that period. A value of m_o greater than one indicates positive TFP growth in that particular period while a value less than one indicates a TFP decline. The Malmquist productivity index is defined as the geometric average of the two indices based on period-*s* and period –*t* technologies since it evaluates productivity under period-*s* technology as well as period-*t* technology. Thus the output-oriented Malmquist productivity index is given by:

$$m_o(y_s, x_s, y_t, x_t) = [m^s{}_o(y_s, x_s, y_t, x_t) \times m^t{}_o(y_s, x_s, y_t, xt)]^{1/2}$$

The above equation computes four distance functions namely,

$d^{s}{}_{o}(y_s, x_s)$, $d^{t}{}_{o}(y_t, x_t)$, $d^{s}{}_{o}(y_t, x_t)$, and $d^{t}{}_{o}(y_s, x_s)$

It is assumed that if any country uses lesser proportion of inputs to produce a given amount of output quantities in both periods *s* and *t*, the TFP index should increase accordingly; if the input use is decreased by a proportion while the amount of output quantities produced remain the same in both periods, then TFP should increase by that same proportion; and if the outputs are increased by a given percentage, keeping the inputs fixed, then the TFP index should increase by the same percentage.

Since the productivity growth for any country is determined by the product of efficiency and technical changes then any growth in a particular year can be attributed to changes in technical change and/or efficiency change. Since it is possible for a country to be technically inefficient in both periods *s* and *t*, however, if the country is found to achieve growth despite being inefficient, then the observed productivity improvement (growth) could be as a result of improvements in efficiency change and/or in the underlying production technology (technical change). The Malmquist TFP index is then decomposed into two components, one measuring efficiency change and the other measuring technical change. Also, since the output-oriented Malmquist TFP change index measures the geometric mean of the indices based on period-*s* and period-*t* technologies it can be further defined as:

$$m_o(y_s, x_s, y_t, x_t) = [m^s{}_o(y_s, x_s, y_t, x_t) \times m^t{}_o(y_s, x_s, y_t, xt)]^{1/2}$$

$$= \left[\frac{d^s{}_o(y_t, x_t)}{d^s{}_o(y_s, x_s)} \times \frac{d^t{}_o(y_t, x_t)}{d^t{}_o(y_s, x_s)}\right]^{1/2}$$

$$= \frac{d^t{}_o(y_t, x_t)}{d^s{}_o(y_s, x_s)} \times \left[\frac{d^s{}_o(x_t, y_t)}{d^t{}_o(x_t, y_t)} \times \frac{d^s{}_o(x_s, y_s)}{d^t{}_o(x_s, y_s)}\right]^{1/2}$$

From the latter equation above, the ratio outside the square brackets measures the change in technical efficiency in period *s* relative to period *t*, and the geometric mean of the two ratios inside the square brackets captures the shift in technology between the two periods, evaluated at x_s and x_t. The efficiency change from the equation above is equivalent to the ratio of the Farrel technical efficiency in period *t* to the Farrel technical efficiency in period *s*. The technical change component is the geometric mean of the shift

in technology between the two periods, evaluated at x_t and also at x_s .

To confirm productivity change for any country depends on the value of the TFP index. If any country has a higher level of productivity than is implied by a particular period technology, then the Malmquist TFP index is greater than one, implying that there is a positive change in productivity, and if there is a country with lower level of productivity than that implied in the reference period then the TFP index is less than one implying a negative change in productivity. However, if the country exhibits the same level of productivity in the reference period, then the score for TFP is equal to one implying zero change in productivity.

4.2 Data

The country productivity changes for the Melanesian Countries, outputs and inputs are available over the period from 1961 to 2005 for Fiji, Papua New Guinea, Solomon Islands, Vanuatu and New Caledonia. To construct the Malmquist TFP indexes, time series data set was extracted from the Food and Agriculture Organization (FAO) statistics database on website: http://www.fao.org. The FAO statistics database provides a time series and cross sectional data relating to food and agriculture for about 200 countries around the world. They provide complete data set of variables on production, trade, food security, prices, forestry, consumption fisheries and others in the food and agriculture sector. The FAO database helps to use its datasets in this study for 1961 to 2005.

Two aggregate measures are used instead of the physical output of the commodities; crops and livestock production indices due to problems associated with degrees of freedom discussed by Coelli et al (2005) when using DEA. The DEA model is

composed of two outputs and three inputs. The annual crop net production indices and livestock net productions indices (measured in International US Dollars in millions), are the two outputs used in this study. Three inputs used are arable land in area (hectare), machinery (number of agricultural tractors used in farms) and labor (economically active population in agriculture).

4.2.1 Two Outputs

With importance of both crops and livestock in the Melanesian countries discussed in chapter two (section 2.15 above), two output data sets on annual crop net production indices and livestock net production indices are weighted by 1999-2001 average international commodity prices are used for each country. The importance of including these two data sets in the Malmquist DEA to calculate the TFP change for the Melanesian countries is because in the second stage regression analysis, the data sets used in agricultural imports and exports variables consists of the livestock and crops values in US dollars. Using one of the two output variables to calculate the TFP change will not reflect the true impacts of agricultural exports and imports variables used in the regression analysis with TFP change.

According to the FAOSTAT (2009), indices for agricultural production, the relative level of the aggregate volume of agricultural production for each year is compared with the base period 1999-2001. They are based on the sum of price-weighted quantities of different agricultural commodities produced after deductions of quantities used as seed and feed weighted in a similar manner. The resulting aggregate represents, therefore, disposable production for any use except as seed and feed. To obtain the indices, the aggregate for a given year is divided by the average aggregate for the base

period 1999-2001based on the Laspeyres formula. Since the FAO indices are based on the concept of agriculture as a single enterprise, amounts of seed and feed are subtracted from the production data to avoid double counting them, once in the production data and once with the crops or livestock produced from them.

Based on FAOSTAT, Geary-Khamis formula is used to calculate the International Commodity Prices in order to avoid the use of exchange rates for obtaining continental and world aggregates, and also to improve and facilitate international comparative analysis of productivity at the national level. This method assigns a single price to each commodity. According to the FAO database, the currency unit in which the prices are expressed has no influence on the indices published and the commodities covered in the computation of indices of agricultural production are all crops and livestock products originating in each country. Indices for meat production are computed based on data for production from indigenous animals, which takes account of the meat equivalent of exported live animals but excludes the meat equivalent of imported live animals. The data used in the model for the two outputs are presented in the two summarized tables below. Table 4a and 4b summarizes the descriptive statistics of crops and livestock production indices for each country on an annual basis from 1966-2004.

Table 4a Output One: Crops Production Indices

Country	Period	Mean	Max	Min	Standard Deviation
Fiji	1961-2005	99595.02	128104	71142	15036.82
Papua New Guinea	1961-2005	606522.6	912415	319132	178791.6
Solomon Islands	1961-2005	42191.42	68294	23447	13504.98
Vanuatu	1961-2005	34170.49	46636	20935	6054.775
New Caledonia	1961-2005	7205.067	9737	5815	1108.757

Source: FAOSTAT (2009)

Table 4b Output Two: Livestock Production

Country	Periods	Mean	Max	Min	Standard Deviation
Fiji	1961-2005	37341.422	54657	13002	13416.103
Papua New Guinea	1961-2005	381119.4	627805	217890	118575.5
Solomon Islands	1961-2005	3423.3556	4963	1296	1033.0164
Vanuatu	1961-2005	8445.867	12467	3630	2554.309
New Caledonia	1961-2005	9745.089	13377	6549	1970.982

Source: FAOSTAT (2009)

4.2.2 Three inputs

The three input items used in this study are arable land, machinery and labor. Arable land refers to the land that can be used and is used for growing crops and raising animals. Machinery is the number of agricultural tractors used in farms per year and labor is approximated by economically active population in agriculture. Data for agriculture inputs are extracted from FAOSTAT database with their units of measurements. Arable land in area (1000 hectares), machinery (annual number of agricultural tractors used in farms) and labor (economically active population in agriculture in 1000 people).

Based on FAOSTAT database, the arable land includes land under temporary agricultural crops (multiple-cropped areas are counted only once), temporary meadows for mowing or pasture, land under market and kitchen gardens and land temporarily fallow (less than five years). The abandoned land resulting from shifting cultivation is not included in this category. Data for “Arable land” are not meant to indicate the amount of land that is potentially cultivable. Data are expressed in 1000 hectares. Agricultural tractors generally refer to wheel and crawler or track-laying type tractors (excluding garden tractors) used in agriculture. Data are expressed in numbers in use in the agricultural sector. Agriculture labor is defined as economically active population in

agriculture (agricultural labor force) is that part of the economically active population engaged in or seeking work in agriculture, hunting, fishing or forestry. Tables 4c, 4d and 4e summarizes the descriptive statistics agriculture of arable land, machinery (tractors) and labor for each country on an annual basis from 1966-2004.

Table 4c Input One: Arable Land

Country	Periods	Mean	Max	Min	Standard Deviation
Fiji	1961-2005	127111.1	200000	67000	52466.1
Papua New Guinea	1961-2005	157844.4	240000	75000	50593.73
Solomon Islands	1961-2005	12711.1	18000	10000	2685.16
Vanuatu	1961-2005	17333.3	20000	10000	3404.54
New Caledonia	1961-2005	7266.667	10000	5000	1136.182

Source: FAOSTAT (2009)

Table 4d Input Two: Machinery

Countries	Periods	Mean	Max	Min	Standard Deviation
Fiji	1961-2005	4393.93	6952	950	2043.1
Papua New Guinea	1961-2005	1200.18	1429	902	105.4
Solomon Islands	1961-2005	6.33	9	4	2.01
Vanuatu	1961-2005	52.24	75	3	25.7
New Caledonia	1961-2005	1124.978	1945	320	575.9674

Source: FAOSTAT (2009)

Table 4e Input Three: Labor

Country	Periods	Mean	Max	Min	Standard Deviation
Fiji	1961-2005	101822.2	135000	67000	21335.3
Papua New Guinea	1961-2005	1422622.2	2032000	997000	316179.6
Solomon Islands	1961-2005	107733.3	178000	57000	37153.5
Vanuatu	1961-2005	24933.3	32000	17000	4554.7
New Caledonia	1961-2005	34022.22	42000	24000	5929.468

Source: FAOSTAT (2009)

4.3 The Regression Model

In determining the growth levels of each country, linear regression model was employed to identify determinant factors that might have impacts on the growth of agriculture productivity in the Melanesian countries. The cumulative TFP changes of the five countries were regressed against determinant variables. The commonly used growth equation that is frequently used in empirical studies is specified below. The implicit function is presented by the following function:

$q_{it} = f(x_1, x_2 .. x_3)$.

The estimation empirical model used for Solomon Islands is specified below in equation 1with two dummy variables *(*MSG_{it} and $TFPch_{it}$)

(Equation 1)

$$TFP_{it} = \alpha_0 + \alpha_1 FAID_{it} + \alpha_2 FAID*FAID_{it} + \alpha_3 AGEXP_{it} + \alpha_4 AGIMP_{it} + \alpha_5 NDISAS_{it} + \alpha_6 MSG_{it} + \alpha_7 TFPch_{it} + \varepsilon_{it}$$

New Caledonia has three dummy variables used are denoted as (MSG_{it} , $TFPch1_{it}$ and $TFPch2_{it}$). It is shown in the model below.

(Equation 2)

$$TFP_{it} = \alpha_0 + \alpha_1 FAID_{it} + \alpha_2 FAID*FAID_{it} + \alpha_3 AGEXP_{it} + \alpha_4 AGIMP_{it} + \alpha_5 NDISAS_{it} + \alpha_6 MSG_{it} + \alpha_7 TFPch1_{it} + \alpha_8 TFPch2_{it} + \varepsilon_{it}$$

The estimation empirical model used for Fiji, Papua New Guinea and Vanuatu is the same as in equation 1 and 2 above but is adjusted to have one dummy variable denoted for all countries as MSG_{it}. Dummy variables ($TFPch_{it}$, $TFPch1_{it}$ and $TFPch2_{it}$) used in equation 1 and 2 are not included here in equation 3 because the sudden drop in the TFP are not used for these three countries.

(Equation 3)

$$TFP_{it} = \alpha_0 + \alpha_1 FAID_{it} + \alpha_2 FAID*FAID_{it} + \alpha_3 AGEXP_{it} + \alpha_4 AGIMP_{it} + \alpha_5 NDISAS_{it} + \alpha_6 MSG_{it} + \varepsilon_{it}$$

In the above models, TFP_{it} is the Malmquist TFP index from the DEA calculation for the *i-th* country in period *t* approximation of growth rate of total factor productivity. The subscripts i and t refer to the i th country and the t th observation, $\boldsymbol{\varepsilon}_{it}$ = the value of the stochastic error term for the i th country.

Foreign aid (FAID) is used in the model to capture its effectiveness with TFP and as such, a non-linear relationship between the two was specified and $FAID_{it)}$ is included to show foreign aid received by *i* country in *t* period. To show the direction of the relationship, quadratic term was used ($FAID*FAID_{it}$) and that is the square of foreign aid received by country *i* in the *t* period. It is expected that if $FAID_{it)}$ has a positive coefficient, $FAID*FAID_{it}$ will have a negative coefficient and vice-versa, if $FAID_{it}$ has a negative coefficient, $FAID*FAID_{it}$ will have a positive coefficient. Statistical evidence shows that Foreign Aid has contributed immensely to economic growth (Feeny, 2007; Pavlov et al. 2006; Burnside and Dollar, 1997) in developing countries including those of the South Pacific. Since developing country's economy relies more on agriculture, it forms a foundation to the economic growth.

Agriculture export as a variable in this model consists only on the value of livestock and crops products in US dollars excluding exports of agricultural machines or technologies. Agricultural export (AGEXP) is denoted as $AGEXP_{it}$ and is the value of the agricultural exports received by *i*-eth country in period *t*. The impact of agricultural export ($AGEXP_{it}$) on TFP is not clear in literatures, but a country can improve the TFP by

the value of exports received. A positive coefficient is expected if a country has high agriculture export values hence its direct link to the farmers as the producers of farm products exported are immense.

Agricultural import used in this model as a variable consist only on the value livestock and crops product in US dollars excluding imports of agricultural machines and technologies. The inclusion of agriculture import in the model is to capture its influence on TFP. Agricultural import (AGIMP) is denoted as $AGIMP_{it}$ and is the value of agriculture imported goods (food) received by *i*-eth country in period *t*. It is expected that drastic increase of agriculture import value over the period will impact a negative coefficient.

Lopez et al. (1996) states that although imports alone have effect on domestic market by lowering domestic prices, the direction and strength of their impact on price cost margins depends on the interaction of economies of scale, conjectural variation, and demand elasticities. Imports can have a positive or negative impact on domestic price cost margins consistent with weak economies of scale and low elasticities of demand can have a negative impact on price cost margins, especially in markets characterized by strong economies of scale and high elasticities of demand. Sharma et al. (2005) study in Tanzania and Senegal shows rapid growth in poultry imports have weakened the domestic processing industry in competing with imported products, particularly in situations where there has been rapid growth in demand for further processed quality products which the local industry and has resulted in failing to supply.

While on the other hand a low rate of agriculture imports with spillover effects will have positive coefficients on TFP. There can be spillover effects on agriculture

imports when it is associated with research and development (R&D) and foreign direct investment (FDI). Foreign R&D has the advantage that they might give stronger effects when imports account to a large percent (Luh et al. 2008).

Importation of agriculture inputs such as machines, seeds, commercial feeds, raw feed materials, fertilizers, animal drugs and pesticides can have positive impacts on agriculture productivity however; importation of only food and food products can have negative impacts on productivity when the same product can be produced by the importing country (Sharma et al. 2000). Such a situation will have significant negative impacts on agriculture productivity.

Borgatti (2008) and McGregor (2007) argue that agriculture exports in developing countries have a lot of hindrances hence; the amount of exports in the Melanesian countries may not have any correlation. Barriers to agriculture exports for Melanesian countries include high transport costs due to far distances from developed countries and inability to meeting quarantine requirements of other countries. On the other hand, the negative impacts agriculture imports posed on developing countries will also have negative impacts on their agricultural productivity (Dimaranan, 2004; Sharma, 2006). The major factor here is imports of agriculture products from developed to developing countries are cheaper hence local agriculture production will be affected. Dimaranan (2004) highlighted that because developed countries imposing of high subsidies on their farmers, production cost is low and as such developing countries will continue to import agricultural products while their agricultural productivity will continue to decline.

In the model natural disasters (NDISAS) is denoted as $NDISAS_{it}$. To control for natural disaster influence on agricultural productivity, we use dummy variable that is

activated whenever in country *i* a natural disaster occurred in period (time) *t*. Natural disaster frequency or cost could be used instead of dummy variables but these variables failed to give a clear explanation of the impacts of environmental shocks in agriculture production. If negative results are shown, we can conclude that there is an evidence of natural disaster impacts or the agriculture sector failed to develop during these adverse effects. The use of natural disasters in the model should show negative impacts on agriculture productivity as discussed by Mirza (2003); Campbell (1985) and Rasmussen (2004) on natural disaster prone regions in the world. They discussed the negative influence natural disasters can have on national economies, infrastructure and agricultural productivity is very high.

In the regression model, joining MSG trade is also included as a dummy variable is denoted as MSG_{it} for all countries. MSG_{it} is defined as when each country joins the regional MSG trade organization. To capture if after joining the MSG trade organization will influence the TFP of each country. Plummer et al. (2001) states that such a trade organization can have benefit from each other through FDI spillovers as in the ASEAN. Anderson et al. (2007) explains that developing countries can reduce cost of barriers by 40 percent from developed countries, and this has set the idea of segmented regional trade organizations for economies to benefit from their comparative advantages. In the series, it is specified that in three *i*-eth countries (Papua New Guinea, Solomon Islands and Vanuatu) that join the MSG at the same time in 1993 will have a same specification. That is before 1993 each country will have zero (0) and in 1993 and years thereafter each will have a value of one (1). Fiji joined the MSG in 1997 and as such, MSG_{it} will be zero (0) in years before 1997 and will have a value of one (1) in 1997 and years thereafter. New

Caledonia likewise joins MSG in 2001and will have MSG_{it} value of zero before 2001 and value of one (1) in 2001 and years thereafter. It is expected that countries will have positive coefficients for (MSG_{it}) if a country benefits greatly from the organization through the agriculture sector. From such an organization more agricultural products can be exported hence, it will have direct influence on the famers of these countries to increase agricultural productivity when more than 70 percent (on average) of the population that live in the rural areas depend on agriculture (Fleming, 2005, 2007; CIA World Fact Book, 2009).

Sudden change in the cumulative TFP change was also used as a dummy variable denoted as $TFPch_{it}$ for Solomon Islands. The dummy $TFPch_{it}$ is used to capture whether the two periods (period 1: 1966 – 1986 and period 2: 1987 – 2004) are different from each other (refer to figure 5.3) in terms of better or worse in agriculture productivity. Thus in the time series, it is specified that from 1966 – 1986, the value is zero (0) and 1987 – 2004 its value is 1 (1). In 1966 – 1986, TFP is increasing and 1987 – 2004 TFP drop significantly hence, by using the value of zero (0) for the first period and one (1) for the second period, it will have a negative coefficient.

Similar to Solomon Islands TFP, New Caledonia has three phases in the TFP and as such, two dummies variables are used to compare three periods of cumulative TFP change denoted as $TFPch1_{it}$ and $TFPch2_{it}$. The second period (1974 – 1989) had a significant drop in cumulative TFP change than period one (1966 – 1973) and period three (1990 – 2004) (refer to figure 5.5). To compare period 1 and period 3 with period 2, two dummy variables are used and expected positive coefficient will be achieved for period 1 and 3. Thus in the time series it was specified that $TFPch1_{it}$ has a value of one

(1) for 1966 to 1973 and value of zero (0) for 1974 – 2004. Likewise, $TFPch2_{it}$ has a value of zero (0) for 1966 – 1989 and value of one (1) for 1990 – 2004. As such, period 2 of 1974 to 1989 is all zero (0).

4.3.1 Data

The data set for each country used to explain the growth factor of the agriculture sector begins from 1966 and ends in 2004. With the limitation of Foreign Aid data for New Caledonia, data set for all Melanesian countries on all variables begin in 1966 and ends in 2004. Determinant variables used for the regression analysis are; Foreign Aid, Agricultural Exports, Agricultural Imports, Natural Disasters and Dummies for years each country joined the Melanesian Spearhead Group and years the TFP change had dropped for two countries.

4.3.1.1 Foreign Aid

In order to evaluate the effects of foreign aid in agriculture productivity, variables are obtained from the Net Official Development Assistance (ODA). Data set on foreign aid for the Melanesian countries' are derived from World Resources Institute (WRI) database on website: http://earthtrends.wri.org/ in current US dollars from 1966 to 2004. According to WRI database, aid received is the amount of official development assistance (ODA) received by a country and refers to the actual international transfer by the donor of financial resources or of goods or services (valued at the cost to the donor), less any repayments of loan principal during the same period. Data are in million current U.S. dollars, converted at official exchange rates. ODA consists of loans and grants given to countries and territories on the development assistance committee (DAC) list of aid recipients by multilateral organizations, DAC member countries, and non-DAC donors.

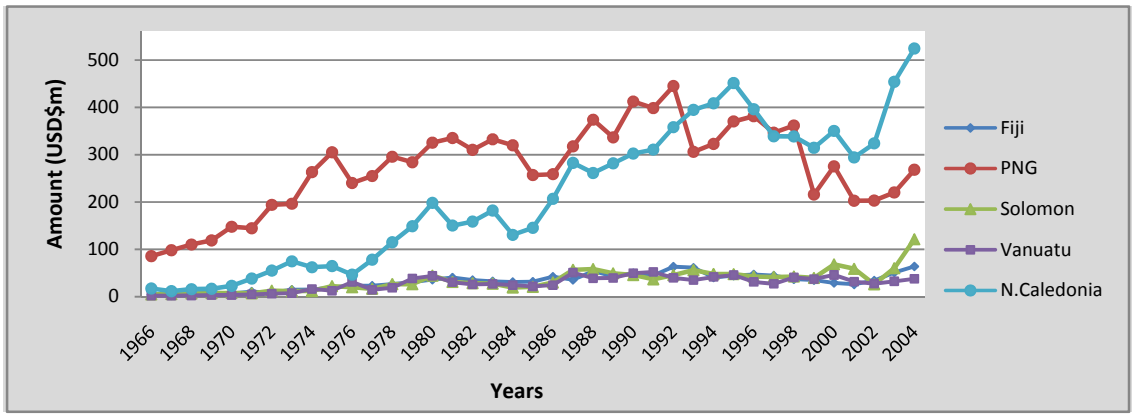
According to the Foreign Aid Policy; to qualify as ODA, grants or loans must promote economic development and welfare as the main objective, must be undertaken by the official sector, and must be provided at concessional financial terms (all loans must have a grant element of at least 25 percent). Technical cooperation and most expenditure for peacekeeping under UN mandates and assistance to refugees are generally included and in here is evident in the case of Solomon Islands and Papua New Guinea. Table 4f summarizes the descriptive statistics of foreign aid for each country on an annual basis from 1966-2004.

Table 4f Foreign Aid

Country	Periods	Mean	Max	Min	Standard Deviation
Fiji	1966-2004	32.07949	63.9	2.7	16.70235
Papua New Guinea	1966-2004	272.7154	445.2	85.6	90.68502
Solomon Islands	1966-2004	34.22564	121.3	4.8	23.04262
Vanuatu	1966-2004	27.27949	52.2	2	15.35345
New Caledonia	1966-2004	213.4128	524.3	11.6	148.4573

Source: World Resources Institute database (2009)

Figure 4a Trend of Foreign Aid from OECD to Melanesian countries (1962-2005)



Source: World Resources Institute database (2009)

4.3.1.2 Agricultural Exports

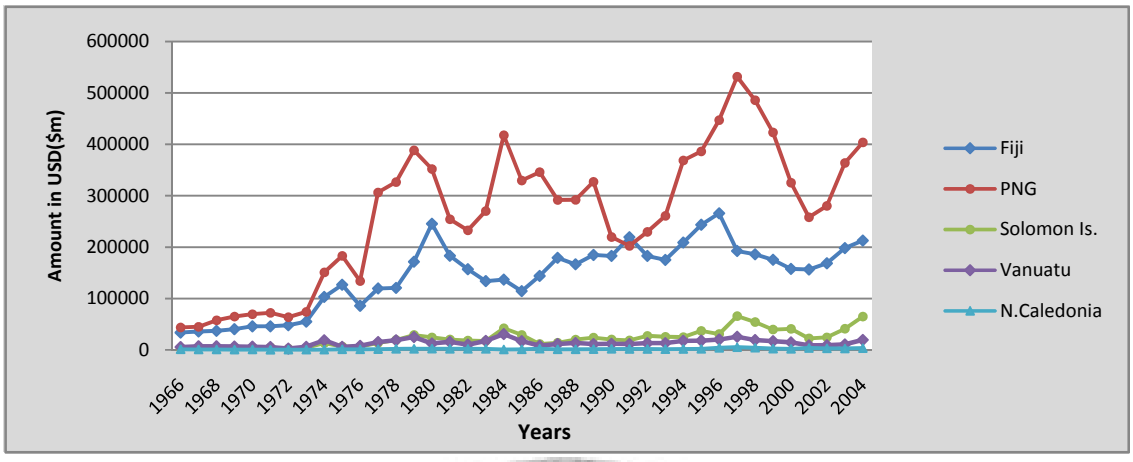
Data on agricultural exports is also taken from the FAO (FAOSTAT) database on website: www.fao.org. The Agricultural export data set consists of total value of agricultural products exported in US$ (million) per year to other countries or within the Melanesian countries. It consists only on the value of livestock and crops products in US dollars excluding exports of agricultural machines or technologies According to FAOSTAT (2009) database, the unit value indices for the aggregate agricultural and aggregate food products represent the changes in the quantity-weighted unit values of products traded between countries. The weights are the quantity averages of 1989-1991. The formulas used are of the Laspeyres one and Indices for food products include commodities that are considered edible and contain nutrients, except for animal feed products and alcoholic beverages. Coffee and tea are also excluded because, although edible, they have practically no nutritive value. However, value indices represent the change in the current values of export free on board (FOB) all expressed in US dollars. Table 4g summarizes the descriptive statistics of agriculture exports for each country on an annual basis from 1966-2004.

Table 4g Agriculture Export

Country	Periods	Mean	Max	Min	Standard Deviation
Fiji	1966-2004	144.63	265.869	33.690	64.605
Papua New Guinea	1966-2004	263.58	531.686	43.648	134.011
Solomon Islands	1966-2004	22.54	65.776	2.382	16.351
Vanuatu	1966-2004	132.45	30.803	2.488	6.311
New Caledonia	1966-2004	1.78	5.176	0.185	1.124

Source: FAOSTAT (2009)

Figure 4b Trend of Agricultural Exports from Melanesian countries (1966-2004)



Source: FAOSTAT (2009)

4.3.1.3 Agricultural Imports

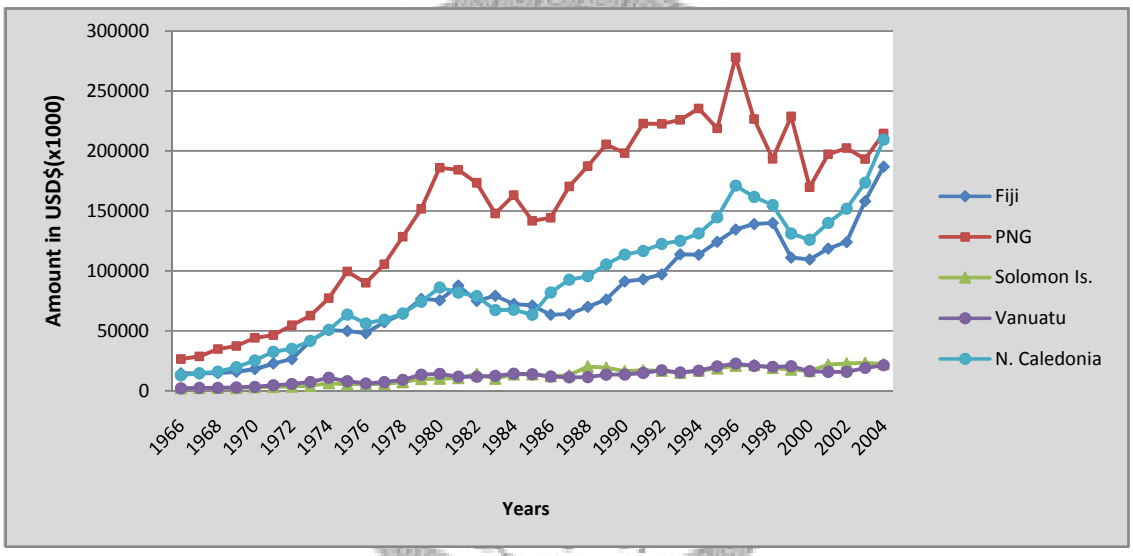
In order to analyze the impacts of agricultural imports, data set on agricultural imports is taken from the FAO (FAOSTAT) database on website: www.fao.org. Agricultural import data set consists of total value of agricultural products imported in US$ (million) per year from other countries or from within the Melanesian countries. It consists only on the value of livestock and crops products in US dollars excluding imports of agricultural machines or technologies. The data set also consists of both the value of crops and livestock products imported. According to the FAOSTAT (2009), unit value indices represent the changes in the quantity-weighted unit values of products traded between countries. The weights are the quantity averages of 1989-1991 using the Laspeyres formula. Finally, value indices represent the change in the current values of import cost, insurance and freight (CIF) are all expressed in US dollars. For countries which report import values on an FOB basis, these are adjusted to approximate CIF values by a standard factor of 112 percent. Table 4h summarizes the descriptive statistics of agriculture imports for each country on an annual basis from 1966-2004.

Table 4h Agriculture Import

Country	Periods	Mean	Max	Min	Standard Deviation
Fiji	1966-2004	79.6521	186.994	14.522	43.01
Papua New Guinea	1966-2004	151.86	278.104	26.512	70.55
Solomon Islands	1966-2004	12.48	23.329	2.183	6.964
Vanuatu	1966-2004	12.374	22.718	2.019	5.867
New Caledonia	1966-2004	91.33	209.528	12.92	50.554

Source: FAOSTAT (2009)

Figure 4c Trend of Agricultural Imports by Melanesian countries (1966-2004)



Source: FAOSTAT (2009)

4.3.1.4 Natural Disasters

Data on Natural Disasters for the five countries are obtained from EM-DAT: The OFDA/CRED International Disaster Database – www.emdat.net_Universite' Catholiques de Louvain – Brussels- Belgium, the most comprehensive database on natural disasters that is publicly available. Data used in this study is based on the OFDA/CRED specification that natural disaster may exist in a country when ten or more deaths occur, at least 100 people are affected and or when the country affected asks for international

disaster relief supplies and help from other international countries. The database is divided into disaster types and considerations are made that only those related to agriculture can be used.

The database is constructed and compiled from various sources including United Nations (UN), governmental and non-governmental agencies, insurance companies, research institutes and press agencies. The database also included in their compilation a list of disaster occurred per year, types of disaster, number of people affected and number of deaths. Data used are based on the concept of meeting the criteria more than 200 are affected per country. Data for this dummy variable shows an existence of disaster(s) in a year given one (1) or no disaster in a year given as zero (0). The disaster types include drought, earthquake, disease epidemic, flood, tropical storm, landslides, tsunami, volcano and wildfire. Table 4i summarizes the descriptive dummy statistics of natural disasters for each country from 1966-2004.

Table 4i Total Natural Disaster Occurrence

Country	Period	Disaster	No Disaster
Fiji	1966-2004	1	0
Papua New Guinea	1966-2004	1	0
Solomon Islands	1966-2004	1	0
Vanuatu	1966-2004	1	0
New Caledonia	1966-2004	1	0

Source: The OFDA/CRED International Disaster Database – www.emdat.net_Universite'

4.3.1.5 Dummy Variables

4.3.1.5.1 Joining the MSG Trade Organization

Dummy variable *MSG* is used when a country in the Melanesia region is a full member of the MSG trade organization. The three original members of MSG trade are Papua New

Guinea, Solomon Islands and Vanuatu in 1993. As such, from 1966 to 1992 we put zero (0) as a dummy variable when these three countries were not yet members and we put one (1) for 1993 to 2004 when the three countries are members of the MSG trade. Likewise, Fiji being a member of the organization in 1998, we put is zero (0) for the years 1966 to 1997 and dummy one (1) for 1998 to 2004. New Caledonia joined the MSG trade organization in 2001 and like others; we put dummy zero (0) for the years 1966 to 200 and dummy one (1) for 2001 to 2004. How the data is arranged is summarized in table 4j.

Table 4j Description of dummy variables for MSG

Country	**Periods** *Member of MSG*	**Dummy unit**	**Periods** *Not a member of MSG*	**Dummy unit**
Fiji	1998 - 2004	1	1966 - 1998	0
Papua New Guinea	1993 - 2004	1	1966 -1992	0
Solomon Islands	1993- 2004	1	1966 - 1992	0
Vanuatu	1993 - 2004	1	1966 - 1992	0
New Caledonia	2001 - 2004	1	1966 - 2000	0

4.3.1.5.2 Sudden Drop on TFP

The dummy variable $TFPch_{it}$ is used to capture whether two periods (period 1: 1966 – 1986 and period 2: 1987 – 2004) are different from each other (refer to figure 5.3) in terms of better or worse in agriculture productivity of Solomon Islands. Thus in the time series, it is specified that period one (1966 – 1986) of the cumulative TFP change be given a dummy variable of zero (0) and period two (1987 – 2004) is given a dummy variable value one (1).

Similar to Solomon Islands cumulative TFP, New Caledonia has three phases in the TFP and as such, two dummies variables are used to compare the three periods of

cumulative TFP change denoted as $TFPch1_{it}$ and $TFPch2_{it}$. The three periods have distinct features that need comparison and period 1974 to 1989 has a significant drop in cumulative TFP change than period 1966 to 1973 and period 1990 to 2004 (refer to figure 5.5). The purpose is to capture whether the TFP change of each period is better than the others. As such, we put dummy variable one (1) for ($TFPch1_{it}$) 1966 – 1973 and dummy variable value of zero (0) for 1974 – 2004. For dummy variable $TFPch2_{it}$ we put dummy variable value of one (1) for 1990 – 2004 and value of zero (0) for 1966 – 1989. By this arrangement period 2 (1974 – 1989 has zero values.

Table 4k Description of the Dummy Variables used in the TFP Sudden Drop

Country		Periods	Dummy unit	Periods	Dummy unit
Solomon Islands		1966 - 1986	0	1987 - 2004	1
New Caledonia	**($TFPch1_{it}$)**	1966- 1974	1	1975-2004	0
New Caledonia	**($TFPch2_{it}$)**	1966-1989	0	1990-2004	1

Chapter 5.0 Results and Discussion

5.1 Sources of TFP change

In table 5a, we show the TFP and its sources which indicate with the mean statistics the major drivers of the TFP for each country. Result revealed that technology is the major source for the TFP change of Fiji, Papua New Guinea, Solomon Islands and New Caledonia. Efficiency change is the major source for Vanuatu's TFP change, however with the very low technology change of 0.676, TFP change had declined drastically over the study period in the cumulative TFP change as shown in figure 5a.

Table 5a Summary statistical description of the TFP change, Efficiency change and Technology change

Country	TFP and Components	Mean	Max	Min	Standard Deviation
Fiji	*TFPCh*	1.012682	1.126	0.893	0.052043
	EffCh	1.005932	1.232	0.868	0.052944
	TechCh	***1.008068***	1.116	0.853	0.052258
Papua New Guinea	*TFPCh*	1.007	1.091	0.933	0.028806
	EffCh	1	1	1	0
	TechCh	***1.007***	1.091	0.933	0.028806
Solomon Islands	*TFPCh*	1.005614	1.091	0.829	0.047616
	EffCh	1.002432	1.159	0.933	0.026432
	TechCh	***1.003841***	1.108	0.829	0.054727
Vanuatu	*TFPCh*	0.981591	1.221	0.676	0.098719
	EffCh	1	1	1	0
	TechCh	***0.981591***	1.221	0.676	0.098719
New Caledonia	*TFPCh*	1.002205	1.17	0.77	0.080275
	EffCh	1.000795	1.184	0.802	0.068405
	TechCh	***1.001159***	1.001159	0.907	0.036846

5.2 The Empirical Analysis of the TFP Change

Over the study period, results indicate that each Melanesian country has its own TFP growth pattern. An increasing cumulative TFP with fluctuating trends for Fiji while Solomon Islands has a slow increasing trend from the beginning and dropped half way in

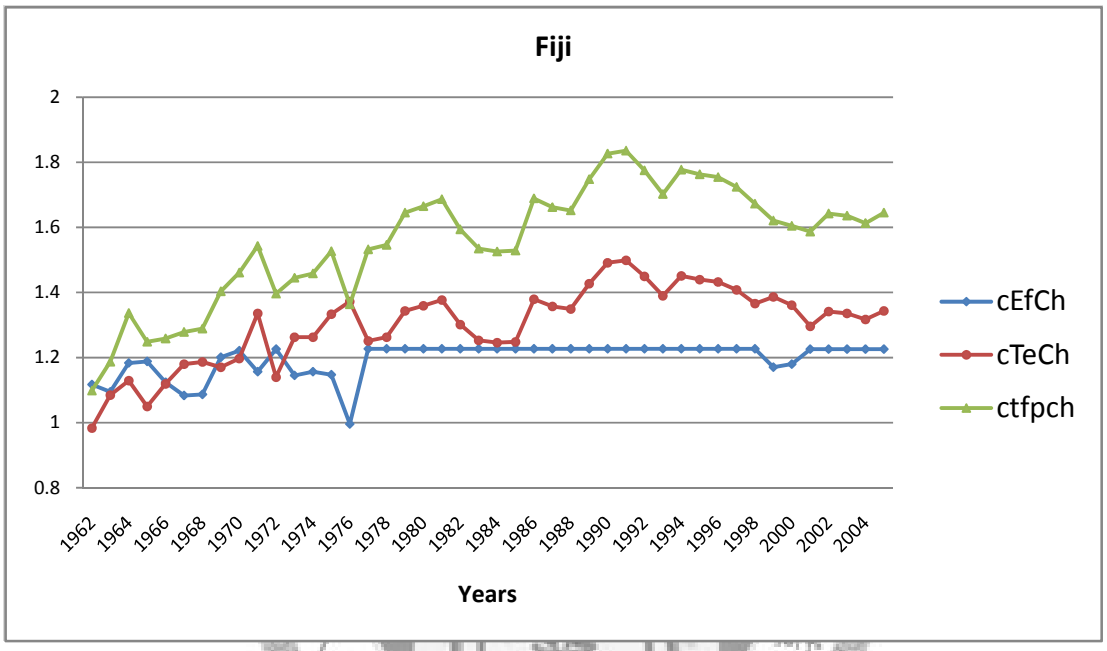
the period. Vanuatu shows a drastic declining trend at the beginning of the period and could not manage to improve its productivity, while New Caledonia has a declining, stagnant and later increasing trend. Papua New Guinea has a smooth fast increasing trend after a fluctuating trend during the first one third part of the study period. The results indicate that the sources of TFP growth rates tend to differ among the economies but improvements in technical change, rather than efficiency change, is the dominant source of growth or decline.

5.2.1 Fiji's TFP Growth Pattern

Result shows that Fiji's cumulative TFP change has been fluctuating at an increasing trend over the entire study period (refer to figure 5a). Its TFP change has depend on both efficiency and technology changes from 1962 to 1976 while from 1977 the TFP change was predominantly depended on the Technology change until 1997, and 2000 to 2005. Fiji's sugar is always the highest in large composition to total agriculture production when compared with other commodities and it is the main source for the increase in the TFP change. This is evident in the increase of famers in 1970 with 15,542 in operation and by 1993, the number peaked to 23,454 (Reddy, 2003) and this is also reflected in the TFP result during the same period. A large proportion for the increase in the number of farms was due to the increase of the World Bank funding to sugarcane farmers. In addition, responding to the better cane price that farmers began to receive after the government took over the sugar milling operations; farmers tend to use progressively marginal land for production. The higher price of sugar in Fiji during those periods well above the world free market price has also attracted marginal land to be used for sugarcane production (Grynberg, 1995). With increased sugar price and funding

within this period, many Indo-Fijian farmers had also invested in machinery and yield had increased drastically (Reddy, 2003) and this has lead to the higher technological change during the same period.

Figure 5a Fiji Cumulative TFP Change and its Components



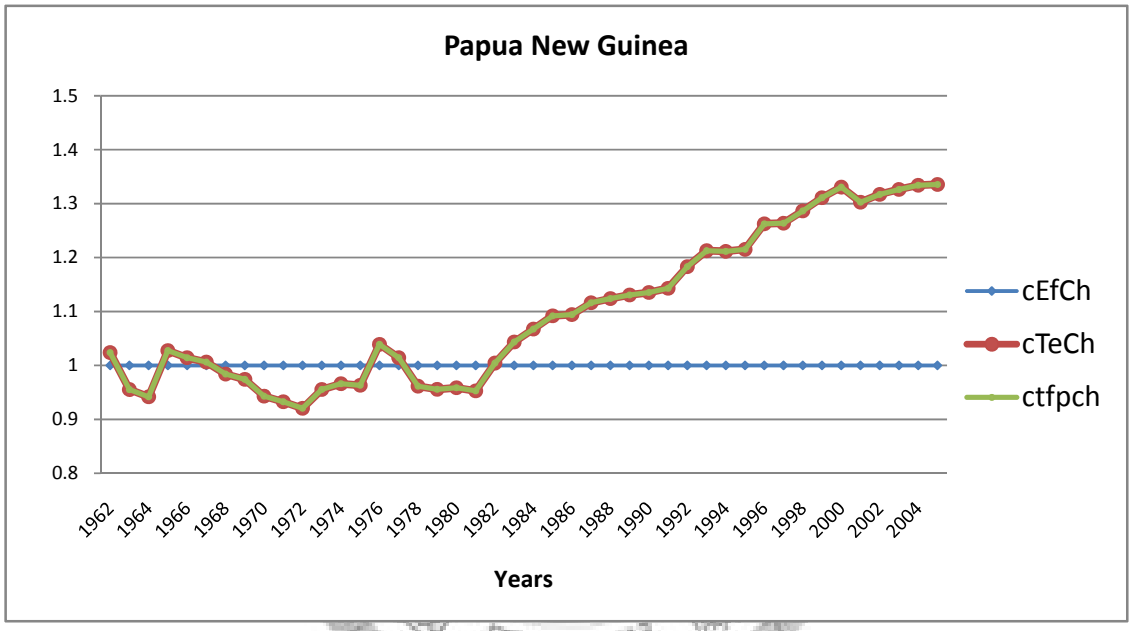
Note: ctfpch - cumulative TFP change; cTeCh – cumulative technological change and cEfCh – cumulative efficiency change.

5.2.2 Papua New Guinea' TFP Growth Pattern

Papua New Guinea had a stable but fluctuating cumulative TFP change from 1962 to 1982 and a steady increasing trend afterwards until 2005 (refer to figure 5b). Its TFP change was influenced by technology change for the entire study period. The efficiency change dictates the economy to remain on the frontier throughout the whole period and has no influence on the TFP change. After 1982, the cumulative TFP change had steadily increased until 2005 which shows improved agriculture productivity that depends entirely on technology change. During this period, there is distinct evidence in which the

circumstances of cash crop producers had changed dramatically to boost its productivity. In the period until the mid-1980s, developments in the smallholder coffee and cocoa industries and the nucleus estate oil palm industry had enabled the factorial terms of trade to also remain fairly steady despite declining real commodity prices (Fleming, 2005), hence it reflects a increasing cumulative TFP change at that time.

Figure 5b Papua New Guinea Cumulative TFP Change and its Components



Note: ctfpch - cumulative TFP change; cTeCh – cumulative technological change and cEfCh – cumulative efficiency change.

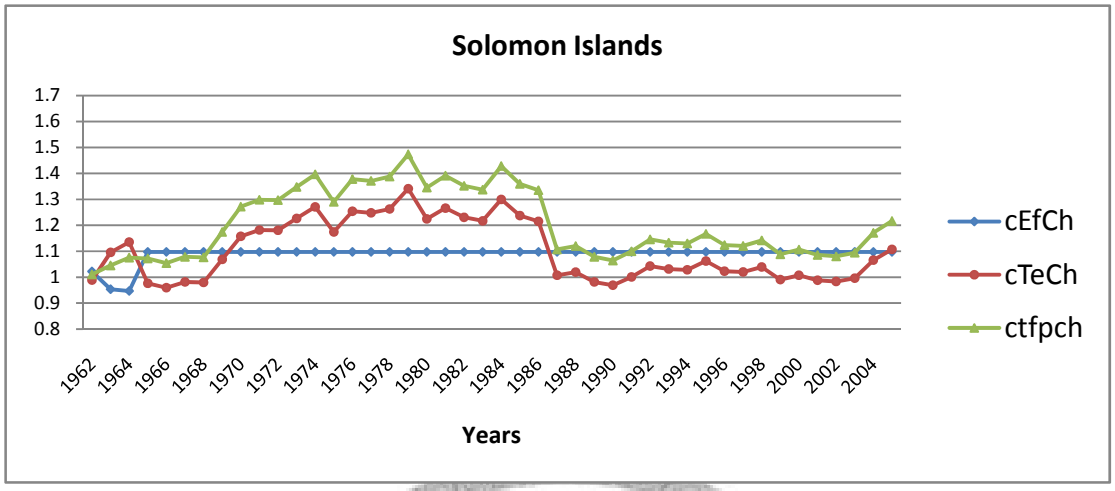
5.2.3 Solomon Islands TFP Growth Pattern

Solomon Islands had an increasing cumulative TFP change from 1962 to 1984 and on the frontier with efficiency change of 1.0 from 1965 until the end of the study period (refer to figure 5c). From 1986, productivity dropped and remained more stable just around 1.0 until 2005. Solomon Islands TFP change has entirely depends on technology change for the whole period and efficiency change did not have effects on the TFP change after 1965.

According to Fleming (2005), Solomon Islands were largely a function of three events and first were due to the commodity boom in the mid-1970s that caused the massive increase in export revenue in the cocoa and copra industries, thus encourages new plantings of these crops. Rehabilitation of existing plantations and the oil palm plantation sector in the early 1970s had also boosted the TFP change until 1986. The main factor for the drastic drop of the TFP was when cyclone Namu destroyed parts of palm oil production in May 1986 (Fleming 1996) with the complete destruction of the domestic rice production of the country. Trustrum et al. 1990 also found that cyclone Namu destroyed buildings, roads, bridges, crops, forests and palm oil plantation production and the complete destruction of the only rice commercial farm in the country. Two major islands that contribute greatly to agriculture production were both affected by the natural disaster.

Another factor that contributed to the decline of TFP growth from 1987-2005 was the downsizing of the European Union (EU) STABEX agriculture funding to help farmers in subsidy. The program ended in the early 1990s. The absence of such major projects with the struggle to rebuild the sector after the disaster takes time and progress to put the TFP at an increasing trend is a major challenge. After 1987, the cumulative TFP change had declined and remained stable around 1.0 until the end of the study period with no improvement and increase.

Figure 5c Solomon Islands Cumulative TFP Change and its Components



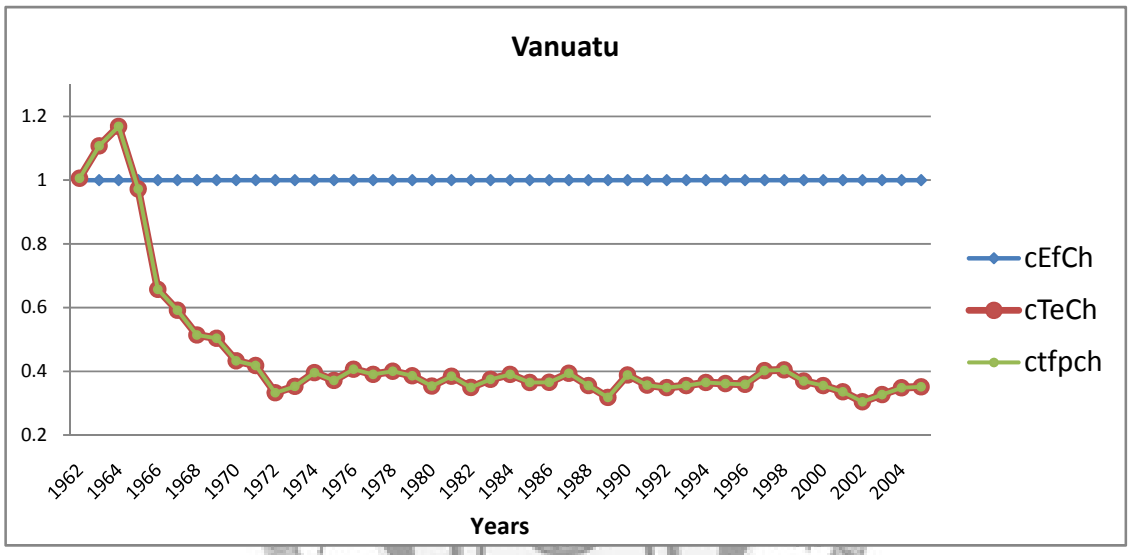
Note: ctfpch - cumulative TFP change; cTeCh – cumulative technological change and cEfCh – cumulative efficiency change.

5.2.4 Vanuatu's TFP Growth Pattern

Vanuatu's cumulative TFP change had a very short increase period from 1962 to 1964 and drastically declined from 1.168 to 0.33 in 1972 and remain stable around 0.4 and 3.0 on the same trend to the end of the study period (refer to figure 5d) with no sign of improvement. Agriculture productivity for this economy deteriorates due to technical regress which also dominates the efficiency change. The drastic decline in the TFP change occurred rightly on the period (1960s and 1970s) when the indigenous people of Vanuatu and the Europeans had land disputes that resulted in the returned of 150,000 hectares of land previously used by the commercial settlers for cattle and plantations to the local land owners in the 1970's (Trease, 1987). Tourism sector has been increasing for this economy before and after independence during the cumulative TFP declining period. With the increasing agricultural imports, agriculture productivity has not been showing signs of improvements over the past three decades. Agriculture production has

never been improved and the TFP change for this country however, depends entirely on the technology change for the whole study period. Despite the drastic decline in the cumulative TFP change, Vanuatu's was on the frontier throughout the study period with the help of their agriculture export.

Figure 5d Vanuatu Cumulative TFP Change and its Components



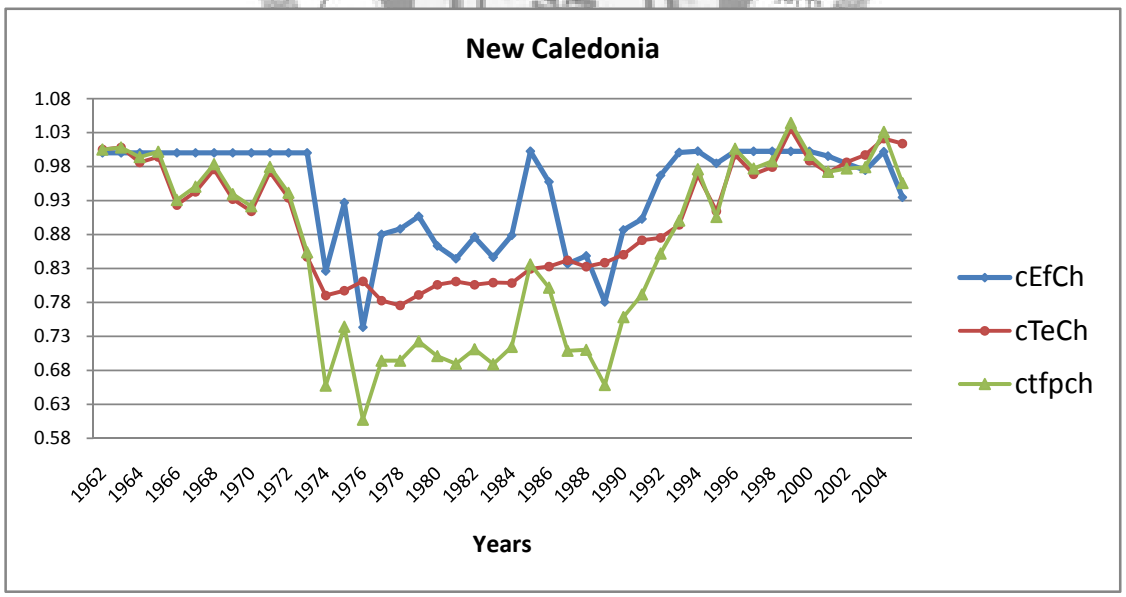
Note: ctfpch - cumulative TFP change; cTeCh – cumulative technological change and cEfCh – cumulative efficiency change.

5.2.5 New Caledonia's TFP Growth Pattern

New Caledonia has three patterns on its TFP growth. In the first period in 1962 – 1973, TFP was declining at a slow rate and influenced by technology change during that period. In the second period (1974 – 1989) the country's cumulative TFP change depends on both technological and efficiency change and the later years the cumulative TFP change depends more on technological change until 2005. Cumulative TFP change of New Caledonia had declined significantly from the beginning and remains stable with fluctuating levels at the bottom in 1974 at 0.7 until 1989 when it started to increase again.

The drop of TFP change was due to the heavy reliant on imports and the gradual increase in the tourism sector for the country during that period. The cumulative TFP change remains around 1.0 from 1997 until 2004 and dropped in 2005. Other evidence been the effect of the 1970's and 80's, when political and land issues for agricultural productivity at the semi and commercial farming level had been hindered by the political tensions in the struggle for independence (New Caledonia Economic Report, 1999). New Caledonia land is predominantly toxic and hinders agriculture production due to the nickel deposits on the island. With only 0.32 percent of the total land (18,575 km^2) is arable for agriculture production (CIA World Fact Book), such a disturbance can cause adverse effects to the agriculture sector. Agriculture in New Caledonia in the in the 1990's and beyond is more towards the use of new technology, innovation and environmentally friendly (Djama, 2004) that resulted in increase TFP growth after 1990.

Figure 5e New Caledonia Cumulative TFP Change and its Components



Note: ctfpch - cumulative TFP change; cTeCh – cumulative technological change and cEfCh – cumulative efficiency change.

5.3 Countries on the Frontier

For a country to remain on the frontier with agriculture productivity, it depends on the efficiency change level a country maintains. In the case of the Melanesian countries, Papua New Guinea and Vanuatu remain on the frontier for the entire study period (1962 – 2005). Despite Vanuatu's declining cumulative TFP change after 1964, it maintains a fluctuating lower level from 1972 – 2005, while Papua New Guinea had an increasing cumulative TFP change from 1981 – 2005. Fiji was on the frontier in 1978 to 1998 and 2002 – 2005. Fiji's inclusion to the frontier since the late 1970's been due to the boom in the increase of sugarcane farmers and increase in sugar price with increased funding from the World Bank (Reddy, 2003). The departure from the frontier after 1998 was due to the fact that many of the land that was leased to Indian farmers were never extended when the lease periods laps in 1997. Solomon Islands was on the frontier from 1966 -2005 and this was due to the boom in the coconut, cocoa and palm oil market boom in the 1970's to 1986 (Fleming, 2005). Despite the drop in 1987, Solomon Islands manage to maintain itself on the frontier until 2005. New Caledonia was on the frontier from 1962 – 1973 and from 1997 – 2000 and was not on the frontier in 1963 – 1996. With only one percent of the total land is arable for farming (CIA World Fact Book, 2009), famers can divert from farming to the booming tourism sector.

Table 5b Countries on the Frontier

Countries	Years on the Frontier	Years NOT on the Frontier
Fiji	1978 – 1998, 2002 – 2005	1962 – 1977, 1999 - 2001
Papua New Guinea	1962 – 2005	none
Solomon Islands	1966 - 2005	1962 - 1964
Vanuatu	1962 - 2005	none
New Caledonia	1962 – 1973, 1997 – 2000	1974 – 1996, 2001 - 2005

5.4 Regression Analysis Results

To explain the level and patterns of agriculture growth in the Melanesian countries, the second stage regression analysis was used to measure the cumulative TFP change as the dependent variable while foreign aid, agricultural exports, agricultural imports, natural disasters and dummy variables are independent variables. Table 5.3 shows the regression results for cumulative TFP with the determinant variables. We can see that foreign aid (FAID) is positively significant for Fiji and Solomon Islands at the percent significance levels. From the result, we can say that foreign aid had lead to positive impacts on the TFP growth for both countries. Despite Feeny (2007) and Hughes (2002) claim that aid does not have any significant impact on the rural areas of Melanesian countries, this result shows evidence that aid does have significant impacts to the rural areas of Fiji and Solomon Islands where agriculture is still the major contributor to the economy and the population. New Caledonia's results show no influence of foreign aid on TFP change in the study period hence, foreign aid does not have any impact on agriculture productivity.

Interestingly, result shows that foreign aid has negative impacts on TFP change for Papua New Guinea and Vanuatu with negative coefficients. The result may have positive coefficients if some important variables are included. Foreign aid in these two countries may reflect Feeny (2007), Hughes (2002) and others arguments that aid had failed in Melanesia. However, it may be true to Pavlov et al. (2006) finding that foreign aid may contribute to growth with decreasing returns on productivity in developing countries. If aid is prioritized to the agriculture sector in these economies, productivity would have increased where large proportions of the population are subsistence farmers.

However, aid in some Melanesian economies will not influence agricultural productivity positively if the criterion for giving aid is based on the scope of government activities, ethnicity, trade, private credit, foreign direct investment, GDP per worker, ethno linguistic fractionalization and education (Ali et al. 2006). Aid should be used on the basis of the need of a country towards economic development (Ali et al. 2006) with good coordination (Akatwijuka, 2004) and on equal inter-sectoral proportions (Kasuga, 2008). Aid coordination failure by donors have also contributed much to the failure of aid to have an impact on economic growth (Akatwijuka, 2004) when lower priority sectors do not get enough funds or overfunding of the lower priority sectors have occurred.

Result shows that when foreign aid is squared, positive directions towards agriculture productivity in Papua New Guinea and Vanuatu can be achieve despite initial negative coefficients. Despite initial positive coefficient for Fiji and Solomon Islands, aid will not be effective to agriculture productivity when it reaches maximum. Aid has negative coefficient on TFP in two economies but achieve positive direction if used effectively in the agriculture sector.

Agriculture export has positive coefficients and is significant for Fiji and Vanuatu as a determinant factor to agriculture productivity. Agriculture export is important in these economies for economic growth with the fact that agriculture contributes 30 – 50 percent to the total GDP (United Nations Statistics Division, 2009) over the past four decades. The positive influence of agriculture export on TFP change in these two economies is due to the fact that Fiji has good stable price and market for their sugar industry in the EU market and Vanuatu's beef industry recent in the last two decades is increasing in the European market (World Encyclopedia of Nations, 2009). As such,

agriculture export will continue to support TFP growth in these countries. However, agriculture export does not have influence on TFP in Papua New Guinea, Solomon Islands and New Caledonia.

The non-influence of agriculture exports on TFP change in Papua New Guinea, Solomon Islands and New Caledonia can be backed by Borgatti (2008) and McGregor (2007) explanations. They argue that agriculture exports in developing countries have a lot of hindrances based on barriers to agriculture exports which includes high transport costs due to far distances from developed countries and inability to meeting quarantine requirements of other countries and quality standards.

The results further show that Papua New Guinea's agriculture imports has a positive impact on TFP change while Vanuatu agriculture imports has negative influence on its TFP change. The positive impact of agriculture imports on Papua New Guinea's TFP shows spillover effects in the areas of animal feed production and genetic studies in crop production. Foreign R&D has the advantage that they might give stronger effects when imports account to a large percent (Luh et al. 2008) and Lopez et al. (1996) in their study, they state that imports can have both positive and negative impacts on domestic prices hence may link to agriculture productivity. Agriculture imports have no significant influence on Fiji, Solomon Islands and New Caledonia's TFP change. On the other hand, the negative impacts agriculture imports posed on developing countries will also have negative impacts on their agricultural productivity (Dimaranan, 2004; Sharma, 2006). The major factor is imports of agriculture products from developed are cheaper thus local agriculture production will be affected. Dimaranan (2004) highlighted that because developed countries imposing of high subsidies on their farmers, production cost is low

and as such developing countries will continue to import agricultural products while their agricultural productivity will continue to decline. Sharma et al. (2005), their study shows that imports of chicken in Senegal had greatly weaken the local chicken production which also has impacts on local production. This means that imports of food products that can be produced locally can have direct negative impacts on the importing country's agriculture productivity.

Table 5c Regression Results for cumulative Total Factor Productivity (TFP) Change with Determinant Factors

Country / *Variables*	**Fiji**	**Papua New Guinea**	**Solomon Islands**	**Vanuatu**	**New Caledonia**
FAID	0.007 (2.205)**	-0.0013 (-2.04)**	0.005 (2.45)***	-0.01 (-3.1)***	-0.00011 (-0.25)
$FAID^2$	-5.02E-05 (-1.42)	2.09E-06 (1.85)*	-3.29E-05 (-2.4)**	0.0001 (3.2)***	5.96E-07 (0.83)
AGEXP	0.001 (2.76)***	5.87E-05 (0.44)	0.002 (1.5)	0.006 (3.1)***	0.03 (1.6)
AGIMP	-0.0005 (-0.78)	0.001 (2.78)***	0.005 (1.1)	-0.01 (-2.3)**	-5.89E-05 (0.043)
NDISAS	0.0003 (0.02)	-0.03 (-1.3)	-0.04 (-1.6)	-0.003 (-0.2)	0.0055 (1.2
MSG	-0.011 (-0.28)	0.17 (4.96)***	-0.01 (-0.22)	0.051 (1.8)*	0.033 (0.73)
D	---	---	-0.35 (-7.2)***	---	---
Da	---	---	---	---	0.26 (5.3)***
Db	---	---	---	---	0.15 (3.4)***
Observations	39	39	39	39	39
R^2	0.83	0.86	0.78	0.64	0.83
R_a^2	0.80	0.83	0.73	0.57	0.79

Note: Numbers in parentheses are t-values. The asterisk (***) denotes significant at the 0.01 significance level, (**) denotes significant at the 0.05 significant level and, (*) denotes significant at the 0.1 significance level.

Despite a lot of discussions on the effects natural disasters have on agricultural productivity, none of the Melanesian countries have shown significant negative influence on the effects of natural disasters on TFP change. As such, we can claim that natural disasters do not have negative impacts on agriculture productivity in the Melanesian countries while this may be true for long-run effects, there can be adverse effects on the immediate impacts of natural disasters. Since we use dummy variables for natural disaster occurrences due to lack of reliability of the measurement, there is a possibility for no significance. These countries are composed of islands dispersed over vast oceans and despite the frequencies of occurrences of tropical storms are high in these economies, Papua New Guinea has the occurrences of earth quakes and volcanoes are found to be high. The effects of tropical storms are evident to be causing a lot of damage to agriculture productivity (Campbell, 2006; Trustrum et al. 1990; Lee, 2004; Mirza, 2003 and Rasmussen, 2004) but with the remote and dispersed nature of the islands of each country, effects from tropical storms may be direct to few islands at a time while rest of the islands in a country may not have any negative impact. The impacts also depends on the level of strength that a storm can cause damage to properties and agriculture.

When dummy variable MSG_{it} for joining the MSG trade is analyzed, results show that after been a member of the trade organization it has positive significant influence only on Papua New Guinea's and Vanuatu's TFP change. Joining any trade organizations means easy access to exports of agriculture products produced by a country. In the Melanesian region, Papua New Guinea and Vanuatu have positive effects to agriculture productivity when joining the Melanesian Spearhead Group as a trading organization of the five countries and this has reflected significantly in their exports of

agriculture products in the region. Joining MSG has not influence on Fiji, Solomon Islands and New Caledonia's TFP change. Fiji's sugar is exported to EU while New Caledonia had joined the trade group recently in 2001and relied more on food imports from France. Plummer et al. (2007) explains the impacts of such an organization in FDI and R&D which can have positive impacts on country's growth as in the ASEAN region. Anderson et al. (2001) also pointed out the benefits of reducing costs of barriers with developed countries. As such, MSG as a regional trade organization greatly benefited these two countries with their small comparative advantages.

The two periods compared for Solomon Islands in the regression analysis $TFPch_{it}$ show that from 1966 – 1986, agriculture productivity is better than the second period of 1987 – 2004. This result is expected since Solomon Islands commodity boom in the mid-1970s has caused the massive increase in export revenue in the cocoa and copra industries that also encourages new plantings and rehabilitation of existing old plantations and the oil palm plantation sector until 1986 (Fleming, 2005). From the results for time dummy (*TFPch1* and *TFPch2*), New Caledonia's TFP change in periods 1966 – 1973 and 1990 – 2004 shows high and better agriculture productivity than period 1974 – 1989. The result indicates that agriculture productivity in New Caledonia has dropped in period 1974 – 1989 and this is partly due to various inter-related factors. In the 1970's and 80's, political and land issues for agricultural productivity for semi and commercial farming level in New Caledonia had been hindered by the political tensions in the struggle for independence (New Caledonia Economic Report, 1999). From this report, evidence has shown that after signing the Noumea Accord for self autonomy in June 1989, this has paved the way for the agriculture sector to grow. With only 1 percent of the total land is

productive for agriculture production (CIA World Fact Book), such a disturbance can cause adverse effects to the agriculture sector.

Chapter 6.0 Conclusion

6.1 The Study Approach

This study focuses on identifying the sources of agricultural growth and its determinant factors for five Melanesian countries of the South Pacific. Country-level data on agriculture production indices are used and provide empirical evidences regarding productivity of these countries over the period 1961-2005. A Data Envelopment Analysis (DEA) procedure is applied. In the first DEA stage, the output-oriented Malmquist productivity indexes and their decompositions are computed using the output orientated Malmquist DEA approach. The calculation of the indexes uses two outputs of net production (1999 – 2001 base years) indices on crop and livestock. Three inputs used are arable land, machinery (annual number of tractors) and labor.

In the second stage, the cumulative TFP for each country is regressed upon various explanatory variables to explain the major determinant factors of TFP growth. The regression analysis shows a time series of cumulative TFP change as the dependent variable starting from 1966 to 2004. A total of six independent variables are included in the regression model which includes foreign aid *(FAID)*, foreign aid squared *(FAID*FAID)*, agriculture exports *(AGEXP)*, agriculture imports *(AGIMP)*, and dummy variables which includes natural disasters *(NDISAS)*, *(MSG)* and *(TFPch, TFPch1 and TFPch2)*.

6.2 The results

In the first-stage Malmquist index results, the TFP growth rate for each country over the study period shows five different TFP growth patterns. Fiji has a fluctuating steady increasing cumulative TFP change while Papua New Guinea had a fluctuating

horizontal trend and later steadily increasing after 1981. Vanuatu posses a declining cumulative trend overall, however it maintains a steady trend towards halfway through the study period. Solomon Islands had two distinct different patterns on the TFP growth, increasing from 1962 – 1986 and sudden drop after 1986 until 2005. New Caledonia had three distinct periods in its TFP growth pattern that period 1 and 3 are better than period 2 (refer to figure 5.5). Major source of TFP growth pattern in the Melanesian region was technical progress rather than efficiency change for countries. The results also indicate that Fiji and Papua New Guinea did well in raising their TFP over time while the rest of the countries either regress or no change at all. Papua New Guinea and Vanuatu manage to remain on the frontier during the study period despite a declining cumulative TFP change pattern was evident for Vanuatu. Other three countries were leveled on the frontier only during certain years during the study period.

The second-stage regression results indicate that the main determinants of TFP change for Fiji and Solomon Islands is foreign aid. For Papua New Guinea and Vanuatu, foreign aid has negative influence on TFP however, it has a positive direction when using *FAID*FAID*. Foreign Aid however has positive significant influence on agriculture productivity in Fiji despite claims from Feeny (2007) and Hughes (2002) that aid fails the Melanesian countries. Agriculture exports are positively significant for Fiji and Vanuatu's TFP growth. Agriculture import has positive influence on Papua New Guinea's TFP growth while it has negative influence on Vanuatu's TFP growth. Joining the MSG trade organization has positive influence on both Papua New Guinea's and Vanuatu's TFP growth. When two distinct periods (D1) are compared for Solomon Islands, TFP is better in the period 1962 – 1986 than period 1987-2005. New Caledonia's

three distinct periods had shown period 1 (1962 – 1973) and period 3 (1990 – 2004) are better than period 2 (1974 – 1989). Other determinant variables have no influence in New Caledonia's TFP change. No Melanesian countries have shown significant influence on the effects of natural disasters on TFP change. As such, we can claim that natural disasters do not have negative impacts on agriculture productivity in the Melanesian countries while this may be a case for further research.

Fleming (2007) in the study of TFP change of four Melanesian countries with Tonga shows a declining growth in agricultural productivity in these countries. By using a single output (crop production in MT) and three inputs, the results of TFP does not show the real importance of crops and livestock to the Melanesian countries. In this study, the use of crops and livestock reflects a true picture of the importance of agriculture to these countries. Despite the declining TFP growth for Vanuatu and New Caledonia's downward fall in the 70's and 80's, three other Melanesian countries have increasing TFP change over 1962-2005. Two aggregate measures are used instead of the physical output of the commodities; crops and livestock production indices due to problems associated with degrees of freedom discussed by Coelli et al (2005) when using DEA.

6.3 Policy implications

Decreasing TFP change in agriculture productivity in some countries of the Melanesia region is a major challenge and an obstacle to sustainable food security and economic development. Land as a factor to agriculture productivity is a major hindrance to economic, agriculture growth and development in the region (Graham, 2006; Fleming, 2007). This is because land cannot be used for any development unless all land owners agree to the development to happen on their land. Land is not owned by individuals but is

owned by tribes and clans in the Melanesian countries. With the increasing land issues and disputes that have been going on in the Melanesian countries for decades, it is the challenge to the policy makers to make appropriate strategies and put in place new land reforms. Land reform programs should be of priority to pave ways for agriculture developments and should focus on land owners are partners of investors.

The empirical evidence shows that foreign aid being one of the main contributors to the regions GDP (Fenny, 2007); it has positive influence on TFP growth of two economies, Fiji and Solomon Islands. This calls for more investment in the areas that will contribute more to agriculture productivity. It is the responsibility of the governments of the Melanesian countries to fully utilize foreign aid for their benefit given the region is already endowed with abundant natural resources (Fleming, 2006; Reddy, 2007 and Feeny, 2007). Better policies on appropriate inter-sectoral allocations of foreign aid and donors giving aid to development priority needs of these countries without aid coordination failure (Ali et al., 2006; Akatwijuka, 2004 and Kasuga, 2008) will bring prosperity to the Melanesian countries agriculture sector.

With positive significant influence of agriculture export on TFP in two economies of the region, correct agriculture policies on domestic and international markets will further boost the TFP growth with reducing imports of agriculture products. Despite no influence to Solomon Islands, Fiji and New Caledonia when joining MSG, government should make efforts to increase its benefit from the trade organization through agriculture sector.

Agriculture being allocated the small portion of the total national budget at all times in these economies does not warranty an increasing TFP growth to these countries.

As such, there is a need to re-look into the budget allocations to the agriculture sector to boost agricultural research and development, extension and services in the rural areas for increase agriculture productivity. Agricultural Policies such as price support programs can enhance farmers' productivity on export products as it occurs in Fiji during the 1980s (Reddy, 2001). Subsidies and development of a vibrant financial system for farmers' to access credit are among other interventions that can stop decreasing TFP in these economies.

6.4 Implications to the Study

There are few important determinant variables for this research work that have not included due to unavailability of reliable data. Data is not available for education, capital formation, infrastructure investment, irrigation, fertilizer consumption, GDP per capita and openness to market. The available of such data would have given a clear picture to make correct, right and complete conclusions to the TFP growth in the agriculture sector of the Melanesian economies.

6.5 Further Areas for Research

To better understand the behavior of the TFP growth in agriculture sector in the Melanesian countries, it is appropriate to make further research on each country's famers to analyze the TFP change. Further analysis can be done to determine the components of TFP change of these farms over a time series. On the regional comparison, similar studies to this research can be done to compare the TFP change of the three regions of the Pacific; the Melanesia, Polynesia and Micronesia. Further analysis of the determinant factors can be used to determine which sectors in the regions can be improved for the importance of food security and agriculture export in the Pacific.

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Appendix

A.1 Correlation Matrix for Fiji

FIJI	*CTFPCH*	*FAID*	*AGEXP*	*AGIMP*	*NDISAS*	*MSG*
CTFPCH	1					
FAID	0.838521	1				
AGEXP	0.881937	0.848603	1			
AGIMP	0.698882	0.803054	0.832769	1		
NDISAS	0.2665	0.360281	0.254992	0.325592	1	
MSG	0.115298	0.207267	0.254362	0.614483	0.212508	1

A.2 Correlation Matrix for Papua New Guinea

PNG	*CTFPCH*	*FAID*	*AGEXP*	*AGIMP*	*NDISAS*	*MSG*
CTFPCH	1					
FAID	0.316458	1				
AGEXP	0.634378	0.617326	1			
AGIMP	0.744904	0.771943	0.809458	1		
NDISAS	0.341314	0.406268	0.439296	0.528076	1	
MSG	0.867936	0.125066	0.57614	0.608801	0.353553	1

A.3 Correlation Matrix for Solomon Islands

SoloIsl	*CTFPCH*	*FAID*	*AGEXP*	*AGIMP*	*NDISAS*	*MSG*	*TFPch*
CTFPCH	1						
FAID	-0.38054	1					
AGEXP	-0.20127	0.697958	1				
AGIMP	-0.45234	0.773885	0.774929	1			
NDISAS	0.036019	-0.29507	-0.1506	-0.18242	1		
MSG	-0.50627	0.591557	0.692197	0.698671	-0.03563	1	
TFPch	-0.74544	0.744515	0.604768	0.856136	-0.26393	0.720082	1

A.4 Correlation Matrix for Vanuatu

Vanuatu	*CTFPCH*	*FAID*	*AGEXP*	*AGIMP*	*NDISAS*	*MSG*
CTFPCH	1					
FAID	-0.5689	1				
AGEXP	-0.23348	0.435797	1			
AGIMP	-0.62635	0.758863	0.635561	1		
NDISAS	-0.28873	0.245041	0.098784	0.388491	1	
MSG	-0.3107	0.388738	0.308203	0.733206	0.398148	1

A.5 Correlation Matrix for New Caledonia

NewCale	*CTFPCH*	*FAID*	*AGEXP*	*AGIMP*	*NDISAS*	*MSG*	*TFPch1*	*TFPch2*
CTFPCH	1							
FAID	0.338338	1						
AGEXP	0.332966	0.650542	1					
AGIMP	0.337071	0.956846	0.78784	1				
NDISAS	0.037113	0.030045	0.100116	0.070855	1			
MSG	0.371689	0.428253	0.417709	0.524775	-0.0786	1		
TFPch1	0.355207	-0.6307	-0.52153	-0.67817	-0.11811	-0.17174	1	
TFPch2	0.590513	0.848216	0.64363	0.849317	0.055141	0.427618	-0.40161	1