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Department of Marketing and Trading Business

COURSE WORK

Theme: Econometric Modeling of Economic Growth in Ghana

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STRUCTURE OF THE COURSE WORK

INTRODUCTION

The relevance of the topic is to ascertain the major macroeconomic factors that would drive Ghana's real per capita GDP growth (economic growth) and also determine which ways these factors significantly influence Ghana's economic growth.

The Goal of the work is to examine the long-run macroeconomic factors of economic growth in Ghana.

Method of data analysis is the use of multiple regression analysis. First, the writer use simple regression analysis to determine the relationship between all the dependent variables and the independent variables. Multiple regression analysis model was then formulated to forecast the productivity of each sector of the economy in the next five years.

Tasks; The study period spanned from 2006 to 2016; The time series properties of the data were, first, analyzed using simple regression analysis to determine how each of the variable unit influences on the output. The output approach was used to measure the economic growth of Ghana's economy.

The object of the study is to manipulate how the agriculture sector, service sector, industrial sector and indirect tax influence of Ghana's Economic growth.

The Subject of the work is economic growth. In this work, economic growth is the same as Gross Domestic Product (GDP).

Added value; this work intends to complement existing work done in the area of economic growth in Ghana. The study would also provide an understanding of the contributions of the various sectors of the economy. For practical relevance, the government of Ghana would benefit from the study because it will enhance the understanding the challenges and problems of the facing each of the sectors of the economy.

Chapter One

Theory of Econometric modeling of economic growth in Ghana using Multiple Linear Regression

1.4 Definitions and tasks of the economic growth econometric modeling.

- **Linear regression**

  Is a linear approach for modeling the relationship between a scalar dependent variable y and one or more explanatory variables (or independent variables) denoted X. The case of one explanatory variable is called simple linear regression. For more than one explanatory variable, the process is called multiple linear regressions. (This term is distinct from multivariate linear regression, where multiple correlated dependent variables are predicted, rather than a single scalar variable.).(Armstrong, J. Scott , 2014).

- **Simple linear regression**

  It is a linear regression model with a single explanatory variable. That is, it concerns two-dimensional sample points with one independent variable and one dependent variable (conventionally, the *x* and *y* coordinates in a Cartesian coordinate system) and finds a linear function (a non-vertical straight line) that, as accurately as possible, predicts the dependent variable values as a function of the independent variables. The adjective *simple* refers to the fact that the outcome variable is related to a single predictor (Pennsylvania State University, 2016).

  Linear regression attempts to model the relationship between two variables by fitting a linear equation to observed data. One variable is considered to be an explanatory variable, and the other is considered to be a dependent

variable. For example, a modeler might want to relate the weights of individuals to their heights using a linear regression model.(Krugman, Paul R.; Obstfeld, M.; Melitz, Marc J. (2012)

- **Multiple linear regressions (MLR)**

It is a statistical technique that uses several explanatory variables to predict the outcome of a response variable. The goal of multiple linear regressions (MLR) is to model the relationship between the explanatory and response variables. (Warne, Russell T. 2011).

- **Economic growth**

  It is an increase in the capacity of an economy to produce goods and services, compared from one period of time to another. It can be measured in nominal or real terms, the latter of which is adjusted for inflation. Traditionally, aggregate economic growth is measured in terms of gross national product (GNP) or gross domestic product (GDP), although alternative metrics are sometimes used.(Hanushek, Eric; Woessmann, Ludger , 2015).

  Economic growth is the increase in the inflation-adjusted market value of the goods and services produced by an economy over time. It is conventionally measured as the percent rate of increase in real gross domestic product, or real GDP(IMF, October 2012).

- **Gross domestic product (GDP)**

  It is a monetary measure of the market value of all final goods and services produced in a period (quarterly or yearly) of time. (Coyle, Diane ,2014).

- **Agriculture**

  It is the cultivation and breeding of animals, plants and fungi for food, fiber, bio fuel, medicinal plants and other products used to sustain and enhance life.(McTavish, E.J.; Decker, J.E.; Schnabel, R.D.; Taylor, J.F. & Hillis, D.M. 2013).

- **Industry**

  It is the production of goods or related services within an economy.[1] The major source of revenue of a group or company is the indicator of its relevant industry. (Charles 2012).

- **Services**

It is a system supplying a public need such as transport, communications, or utilities such as electricity and water. (Lepenies, Philipp April 2016).

- **An indirect tax**

  It is a tax that is paid to the government by one entity in the supply chain, but it is passed on to the consumer as part of the price of a good or service (Garrett, T. J. 2014).

1.2: Multiple Linear Regression method of economic growth econometric modeling.

1.2.1: The Multiple Regression Model

Multiple linear regression attempts to model the relationship between two or more

explanatory variables and a response variable by fitting a linear equation to observed data. Every value of the independent variable *x* is associated with a value of the dependent variable *y* (David A. Freedman 2012).

- A population model for a multiple linear regression model that relates a *y*-variable to *p* -1 *x*-variables is written as;

  yi=β0+β1xi,1+β2xi,2+…+βp−1xi,p−1+ϵi.yi=β0+β1xi,1+β2xi,2+…+βp−1xi,p−1+ϵi

  .

- We assume that the ϵiϵi have a normal distribution with mean 0 and constant variance σ2σ2. These are the same assumptions that we used in simple regression with one *x*-variable.
- The subscript *i* refer to the ithith individual or unit in the population. In the notation for the *x*-variables, the subscript following *i* simply denote which *x*-variable it is. The x-variables in this work will be, Services, industry, agricultural and net indirect tax.
- The word "linear" in "multiple linear regression" refers to the fact that the model is *linear in the parameters*, β0,β1,…,βp−1β0,β1,…,βp−1. This simply means that each parameter multiplies an *x*-variable, while the regression function is a sum of these "parameter times *x*-variable" terms. Each *x*-variable can be a predictor variable or a transformation of predictor variables (such as the square of a predictor variable or two predictor variables multiplied together) (Ehrenberg; Smith 2014).

1.2.2: Identification of the Model Parameters of the Multiple Linear Regression Model

- The estimates of the **ββ** coefficients are the values that minimize the sum of squared errors for the sample. The exact formula for this is given in the next section on matrix notation.
- The letter *b* is used to represent a sample estimate of a ββ coefficient. Thus b0b0 is the sample estimate of **β0β0, b1b1** is the sample estimate of β1β1, and so on (*Rencher, Alvin C.; Christensen, William F. 2012).*.
- **MSE=SSEn−pMSE=SSEn−p** estimates σ2σ2, the variance of the errors. In the formula, *n* = sample size, *p* = number of ββ coefficients in the model (including the intercept) and SSESSE = sum of squared errors. Notice that for simple linear regression *p* = 2. Thus, we get the formula for MSE that we introduced in that context of one predictor.
- **S=MSE−−−−−√S=MSE** estimates *σ* and is known as the *regression standard error* or the *residual standard error*.

  In the case of two predictors, the estimated regression equation yields a plane (as opposed to a line in the simple linear regression setting). For more than two predictors, the estimated regression equation yields a hyperplane, (*Rencher, Alvin C.; Christensen, William F. 2012).*

1.2.3 Interpretation of the Model Parameters

- Each ββ coefficient represents the change in the mean response, E(*y*), per unit increase in the associated predictor variable when all the other predictors are held constant.
- For example, β1β1 represents the change in the mean response, E(*y*), per unit increase in x1x1 when x2x2, x3x3, ..., xp−1xp−1 are held constant (*Rencher, Alvin C.; Christensen, William F. 2012).*.
- The intercept term, β0β0, represents the mean response, E(*y*), when all the predictors x1x1, x2x2, ..., xp−1xp−1, are all zero (which may or may not have any practical meaning).
- The predicted value and residual is calculated as y^i=b0+b1xi,1+b2xi,2+…+bp−1xi,p−1y^i=b0+b1xi,1+b2xi,2+…+bp−1xi,p−1, where the *b* values come from statistical software and the *x*-values are specified by us.
- A **residual** (**error**) term is calculated as ei=yi−y^iei=yi−y^i, the difference between an actual and a predicted value of *y*.
- A **plot of residuals versus predicted values** ideally should resemble a horizontal random band. A departure from this form indicates difficulties with the model and/or data.

- Other residual analyses can be done exactly as we did in simple regression. For instance, we might wish to examine a normal probability plot (NPP) of the residuals. Additional plots to consider are plots of residuals versus each *x*-variable separately. This might help us identify sources of curvature or non-constant variance (*Rencher, Alvin C.; Christensen, William F. 2012)*.

1.2.4 Coefficient adjusted to-multiple correlation

The adjusted R-squared compares the explanatory power of regression models that contain different numbers of predictors (Warne, Russell T. 2011).

Coefficient of Determination - Adjusted - 1

$$R_a^2 = 1-\left(1-R^2\right)\left(\frac{n-1}{n-k}\right)$$

$$R_a^2 = R^2-\left(1-R^2\right)\left(\frac{k-1}{n-k}\right)$$

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where

$$R^2 = r_{yx}^2 = \frac{V(y)-V(e)}{V(y)} = 1-\frac{V(e)}{V(y)}$$

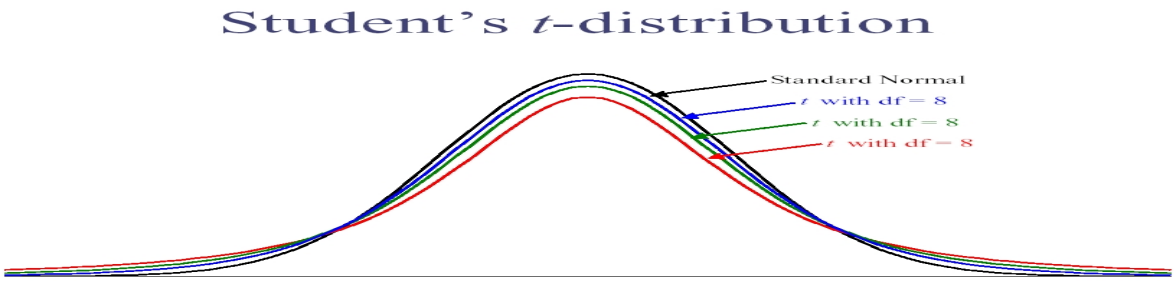
$$R^2 = r_{yx}^2 = \frac{SST-SSE}{SST} = 1-\frac{SSE}{SST}$$

and where n stands for the number of observations
and k represents the number of estimated parameters.

1.2.6: The Statistical Significance of Multiple Regression Coefficients, Students' T-Test

The t test (also called Student's T Test) compares two averages (means) and tells you if they are different from each other. The t test also tells you how significant the

differences are; In other words it lets you know if those differences could have happened by chance (Cohen, J., Cohen P., West, S.G., & Aiken, L.S. 2003).



$$t = \frac{\bar{x} - \bar{y}}{s} \cdot \sqrt{\frac{n_x \cdot n_y}{n_x + n_y}}$$

$$s = \sqrt{\frac{\sum (x_i - \bar{x})^2 + \sum (y_i - \bar{y})^2}{n_x + n_y - 2}}$$

$$\upsilon = n_x + n_y - 2$$

1.3 Methodology of economic growth econometric modeling and forecasting.

The process started with a more thorough collection and analysis of data. The type of data used for this study was secondary data. Time series data on real GDP, agricultural sector, industry sector, service sector, and net indirect tax over the study period (2006 to 2016) were obtained from Ghana Statistical Service (2016). The secondary data was used for the analysis because the verification process is more rapid and the reliability of information and conclusion is greatly enhanced. The secondary data also provided enough information to test the hypotheses of this

study. Finally, it was readily available and hence, convenient to use (Ghauri, et al., 2002).

To carry out the estimation procedure of the link between real per output GDP and its selected macroeconomic factors based on theoretical and empirical review, annual time series data from the period 2006 to 2016 were used. A multiple regression analysis was used to analyze the data and to examine the major macroeconomic factors of economic growth in Ghana. The dependent variable is real GDP per output. The explanatory variables are agriculture, services, industry, and net indirect tax. These variables were chosen because of their authenticity in empirical literature on economic growth and the fact that the state and local policy debate frequently revolves around them. However, the time series properties of the variables of interest were first explored to eliminate any trend element that could lead to spurious parameter estimates. In addition, to determine whether there exist any stable long-run relationships among the variables of interest, the Johansen Maximum Likelihood cointegration test was employed. The computer software used was Microsoft Excel.

The general equation is the following:
$Y= \alpha + \beta 1X1 + \beta 2X2 + \beta nXn + \varepsilon$

Where:

Y = dependent variable

α = constant term

β = coefficient

X = dependent or explanatory variable

n = number of variables

ε = error term (it reflects to other factors that influence Y)

The right hand-side variables in regression tests are the following: agriculture sector, services sector, industry sector and net indirect tax. I tested these variables separately to see how it affects GDP.

The equation will be used to forecast Ghana's economic growth in each sector for the next 5 years.

The 2nd Chapter

Analysis of the economic growth in Ghana

2.1 The state of Ghana economy

Ghana's GDP growth rate of 3.7% in 2016 was certainly a far cry from the record high of 14.0% in 2011, and the lowest in over two decades (GoG, 2017). The 2016 growth outcome was a continuation of the downward trend since 2011. It represented a further decline from the 2015 rate of 3.9%. Although the 2016 outturn of 3.6% growth was substantially higher than the anemic rate of 1.4% registered by sub-Saharan Africa (SSA) as a whole in 2016, it fell short of the 4.1% (revised) target (GoG, 2017). Moreover, the country's overall GDP growth rate was below that of the non-oil sector of 4.6% (GoG, 2017), a continuation of the underperformance of the oil sector.

The downward trend in growth of the Ghanaian economy should be an issue of concern, though falling growth rates are not exclusive to Ghana. Global GDP growth fell from 3.4% in 2015 to 3.1% in 2016, consistent with the trend since 2010 (Table 1.1). Even the recent recovery of the advanced economies appears to have stalled, while developing countries continue to wallow in economic doldrums. The

present malaise of the world economy is apparently a hangover from the global economic and financial crisis of the late 2000s.

Table 1.1: The Non-Oil annual GDP growth rate increased from 4.0 percent in 2015 to 4.9 percent in 2016. The 2015 Non-oil GDP for Industry grew by 3.6 percent compared with -0.7 percent in 2015.

Memorandum Items

Economic Aggregate	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Population estimate (million)	24.66	25.24	25.82	26.43	27.04	27.67	28.31
Exchange rate (Ghana cedis/Dollar) (₵/$)	1.43	1.51	1.81	1.92	2.94	3.78	3.92
GDP current (million Gh₵)	46042	59817	75315	93416	113343	136957	167315
Non-Oil GDP current (million Gh₵)	45865	56070	69666	85974	105550	131264	164090
GDP current	32186	39517	41656	48654	38612	36264	42676

(million US$)							
Per capita GDP (Gh₵)	1867	2370	2916	3535	4192	4950	5910
Per capita GDP (US$)	1305	1566	1613	1841	1428	1311	1507
GDP at constant 2006 prices (million Gh₵)	24101	27486	30040	32237	33522	34808	36016
Non-Oil GDP at constant 2006 prices (million Gh₵)	24031	26012	28248	30121	31310	32575	34161
GDP at constant 2006 prices (million US$)	16848	18158	16615	16790	11420	9217	9186
Growth Rates %	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
GDP at current market prices	25.8	29.9	25.9	24.3	21.3	20.8	22.2
GDP at constant 2006 prices	7.9	14.0	9.3	7.3	4.0	3.8	3.5
Non-Oil GDP at constant 2006 prices	7.6	8.2	8.6	6.6	3.9	4.0	4.9

Change in GDP deflator	16.6	13.9	15.2	15.6	16.7	16.4	28.1

Source: Ghana Statistical Service

2.2 The analysis of Ghana state at the world market.

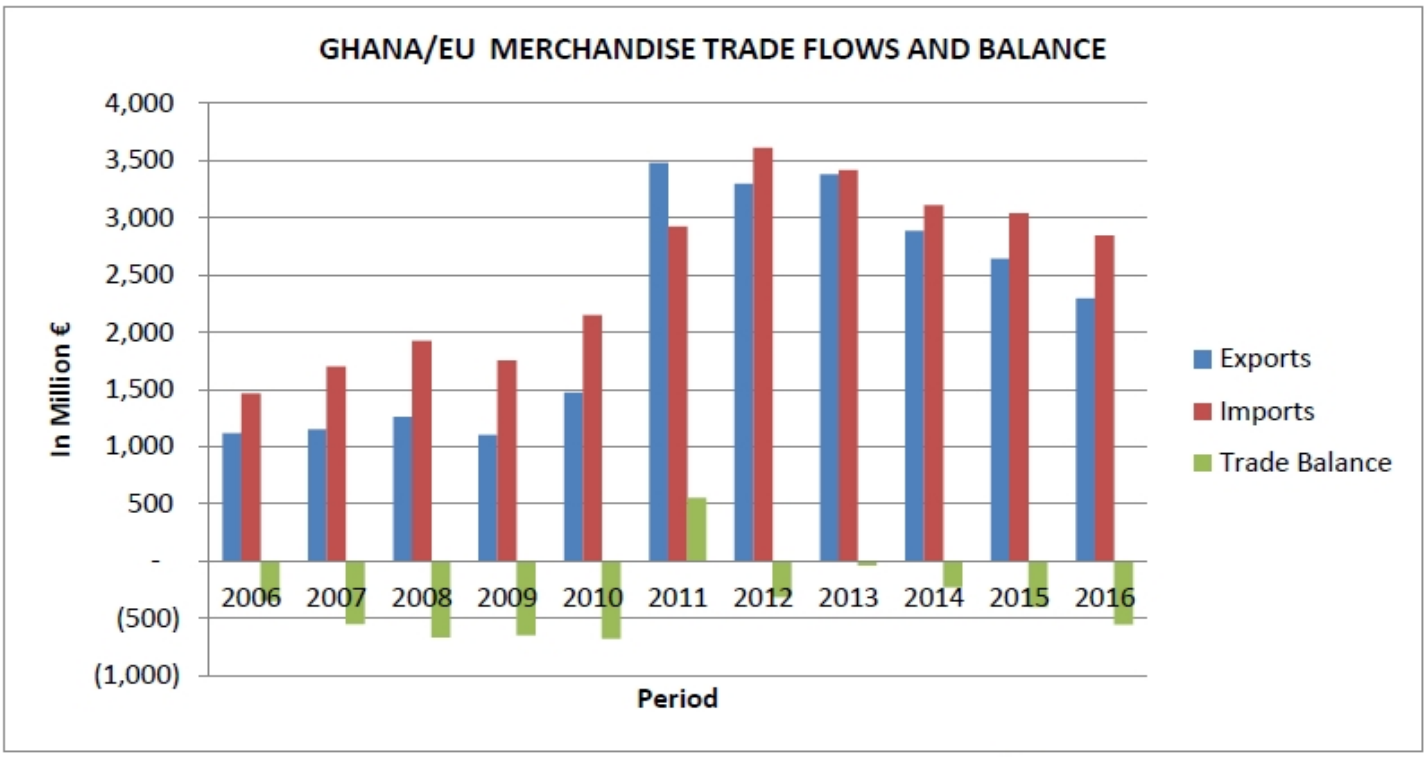
Source (Data.worldbank.org.).

Ghana is the 64th largest export economy in the world. In 2016, Ghana exported $10.5B and imported $11B, resulting in a negative trade balance of $508M. In 2016 the GDP of Ghana was $42.7B and its GDP per capita was $4.29k.

The top exports of Ghana are Gold ($4.43B), Cocoa Beans ($1.89B), Coconuts, Brazil Nuts, and Cashews($987M), Crude Petroleum ($960M) and Sawn Wood($367M), using the 1992 revision of the HS (Harmonized System) classification. Its top imports are Car ($881M), Delivery Tracks ($481M), Cement ($389M), Rice ($287M) and Non-fillet Frozen Fish ($263M).

Export destinations of Ghana are Switzerland ($1.87B), India ($1.56B), the United Arab Emirates ($1.43B), China ($941M) and Vietnam ($549M). The top import origins are China ($4.67B), the United States ($831M), the United Kingdom ($749M), India ($712M) and the Netherlands ($485M). Ghana borders Burkina Faso, Cote d'Ivoire and Togoby land and Benin and Nigeria by sea.

Figure 1: Ghana's Trade Flows And Balance With The European Union (2006 – 2016)



Source: The European Commission (Directorate-General for Trade)[15]

2.3 Factors of Ghana economic growth

2.3.1 Manufacturing

Ghana's industrial base is relatively advanced. Import-substitution industries include electronics manufacturing. RLg Communications is the first indigenous African company to assemble laptops, desktops, and mobile phones, and is West Africa's biggest information and communications technology (ICT) and mobile phone manufacturing company (Kofi Adu Domfeh , 2013).

Ghana began its automotive industry with the construction of a prototype robust SUV, named the SMATI Turtle 1, intended for use in the rough African terrain. It was designed and manufactured by the Artisans of Suame Magazine Industrial Development Organization. Urban electric cars have been manufactured in Ghana since 2014(Kofi Adu Domfeh , 2013).

As of 2012 there were four major companies in the textiles sector: Akosombo Textiles Limited, Tex Style Ghana Limited, Printex Ghana, and Ghana Textile Manufacturing Company (Obeng-Odoom F, 2014).

Ghana National Petroleum Corporation and Ghana Oil Company deal with crude oil and gas exploration, exploitation, and refining.

2.3.2 Telecommunication

Ghana's telecommunications statistics indicated that as of 2013 there are 26,336,000 cell-phone lines in operation. Competition among mobile-phone companies in Ghana is an important part of the telecommunications industry growth of Ghana, with companies obtaining more than 80 per 100 persons as mobile phone and fixed-line phone users (Data.worldbank.org.).

The mass media of Ghana is among the most liberal in Africa, with Ghana ranking as the 3rd freest in Africa and 30th most free in the world on the worldwide press freedom Index. Chapter 12 of the Constitution of Ghana guarantees freedom of the Ghanaian press and the independence of the mass media, and Chapter 2 prohibits censorship.[24] Ghanaian press freedom was restored in 1992 (Data.worldbank.org.).

Ghana was one of the first countries in Africa to achieve the connection to the World Wide Web. In 2010, there were 165 licensed internet service providers in Ghana and they were running 29 of the fiber optic, and authorized

networks VSAT operators were 176, of which 57 functioned, and 99 internet operators were authorized to the public, and private data and packet-switched network operators were 25 (Data.worldbank.org.)

2.3.3 Private Banking

The financial services in Ghana have seen a lot of reforms in the past years. The Banking (Amendment) Act 2007 included the awarding of a general banking license to qualified banks, which allows only indigenous Ghana offshore banks to operate in country Ghana. Indigenous Ghana private bank Capital Bank was the first to be awarded the general banking license in Ghana as well as indigenous Ghana private banks UniBank, National Investment Bank and Prudential Bank Limited. It has therefore become possible for Ghanaian non-resident individuals or residents and foreign companies or indigenous Ghana companies to open indigenous Ghana offshore bank accounts in Ghana. Indigenous Ghana retail and savings banks include Agricultural Development Bank of Ghana, CAL Bank, GCB Bank Ltd, Home Finance Company and UT Bank as well as indigenous Ghana savings and loan institutions ABii National and Savings and Loans Company (Data.worldbank.org.).

2.3.4 Stock exchange

The Stock Exchange of Ghana is one of the largest in Africa, with a market capitalization of GH¢ 57.2 billion or CN¥ 180.4 billion in 2012. South Africa's JSE Limited is the largest, (Data.worldbank.org.).

2.3.5 Imports and Exports

Ghana has the 92nd largest export economy in the world. The top exports of Ghana are Crude Petroleum ($2.66B), Gold ($2.39B), Cocoa Beans ($2.27B), Cocoa Paste ($382M) and Cocoa Butter ($252M). Its top imports are Refined Petroleum ($2.18B), Crude Petroleum ($546M), Gold ($428M), Rice ($328M) and Packaged Medicaments ($297M). With top destinations reaching Switzerland ($1.73B), China ($1.06B), France ($939M), India ($789M) and the Netherlands ($778M). The top import origins are China ($4.1B), the Netherlands ($1.58B), the United States ($1.1B), Nigeria ($920M) and India ($668M) (Data.worldbank.org.).

2.3.6 Energy

As of December 2012, Ghana gets 49.1% of its energy from renewable energy and exports some of this to neighboring countries.

2.3.6.1 : Solar energy

Ghana has aggressively begun the construction of solar plants across its sun-rich land in an aim to become the first country to get 6% of its energy from solar energy generation by 2016. The biggest photovoltaic (PV) and largest solar energy plant in Africa, the Nzema project will be able to provide electricity to more than 100,000 homes.This 155 megawatt plant will increase Ghana's electricity generatingcapacity by 6% (Data.worldbank.org.).

Construction work on the GH¢740 million (GB£248 million) and the fourth-largest solar power plant in the world is being developed by Blue Energy, a renewable energy investment company, majority owned and funded by members of the Stadium Group, a large private asset and development company with GB£2.5

billion under management. The project director is Douglas Coleman, from Mere Power Nzema Ltd, Ghana (Adam Vaughan, 2012).

Unlike many other solar projects in Africa that use concentrated solar power, solar plants will use PV technology to convert sunlight directly into electricity. Installation of more than 630,000 solar PV modules began by the end of 2013, with electricity being generated early in 2014. It is due to reach full capacity at the end of 2015 (Data.worldbank.org.).

2.3.6.2: Wind energy

Ghana has Class 4–6 wind resources and high-wind locations, such as Nkwanta, the Accra Plains, and Kwahu and Gambaga mountains. The maximum energy that could be tapped from Ghana's available wind resource for electricity is estimated to be about 500–600 GWh/year. To give perspective: in 2011, per the same Energy Commission, the largest Akosombo hydroelectric dam in Ghana alone produced 6,495 GWhrs of electric power and, counting all Ghana's geothermal energy production in addition, the total energy generated was 11,200 GWhrs in that year. These assessments do not take into consideration further limiting factors such as land-use restrictions, the existing grid (or how far the wind resource may be from the grid) and accessibility. Wind energy has potential to contribute significantly to the country's energy industry. 10% can certainly be attained in terms of installed capacity, and about 5% of total electric generation potential from wind alone.(Agbenyega, E. 12014).

2.3.7 Bio-energy

Hybrid Sorghum plantation field

Ghana has put in place mechanisms to attract investments into its biomass and bio-energy sectors to stimulate rural development, create jobs and save foreign exchange.

The vast arable and degraded land mass of Ghana has the potential for the cultivation of crops and plants that could be converted into a wide range of solid and liquid bio-fuels, as the development of alternative transportation fuels could help Ghana to diversify and secure its future energy supplies. Main investments in the bio-energy subsector existed in the areas of production, are transportation, storage, distribution, sale, marketing and exportation, (Agbenyega, E. 12014).

The goal of Ghana regarding bio-energy, as articulated by its energy sector policy, is to modernize and examine the benefits of bio-energy on a sustainable basis. Biomass is Ghana's dominant energy resource in terms of endowment and consumption, with the two primary bio-fuels consumed being ethanol and biodiesel. To that effect, the Ghana ministry of Energy in 2010 developed its energy sector strategy and development plan. Highlights of the strategy include sustaining the supply and efficient use of wood fuels while ensuring that their utilization does not lead to deforestation. The plan would support private sector investments in the cultivation of bio-fuel feedstock, the extraction of bio-oil, and refining it into secondary products, thereby creating financial and tax incentives. The Ghana Renewal Energy Act provides the necessary fiscal incentives for renewable energy development by the private sector, and also details the control and management of bio-fuel and wood fuel projects in Ghana. The Ghana National Petroleum Authority (NPA) was tasked by the Renewable Energy Act 2011 to price Ghana's bio-fuel blend in accordance with the prescribed petroleum pricing formula (ghanaoilwatch.org.).

The combined effects of climate change and global economic turbulence had

triggered a sense of urgency among Ghanaian policymakers, industry and development practitioners to find sustainable and viable solutions in the area of bio-fuels.

Brazil, which makes ethanol from maize and sugarcane, is currently the world's largest bio-fuel market.

2.3.8 Energy consumption

Electricity generation is one of the key factors in achieving the development of the Ghanaian national economy, with aggressive and rapid industrialization; Ghana's national electric energy consumption was 265 kilowatts per capita in 2009. Shortages of electricity have led to dumsor (blackouts), increasing the interest in renewables (ghanaoilwatch.org)

2.3.9 Hydrocarbon and Mining

Ghana has 5 billion barrels (790×10^6 m^3) to 7 billion barrels (1.1×10^9 m^3) of petroleum in reserves. A large oilfield which contains up to 3 billion barrels (480×10^6 m^3) of sweet crude oilwas discovered in 2007. Oil exploration is ongoing and the amount of oil continues to increase. Ghana produces crude oil, as of 15 December 2010, and until June 2011, Ghana exploited around 120,000 barrels per day and is expected to increase production up to 2.5 million barrels per day in 2014. Ghana has vast natural gas reserves, which is used by many foreign multinational companies operating in Ghana. The hydrocarbon industry has had major implications for regional and urban development in Ghana and these are likely to substantially increase in the years to come. (ghanaoilwatch.org.)

Mining has gained importance in the Ghanaian economy since the turn of the 21st century, with a growth of around 30% in 2007. The main mining extractions

are bauxite, gold (Ghana is one of the largest gold producers in the world), and the phosphates (ghanaoilwatch.org.)

2.3.10 Toursim

The Ministry of Tourism has placed great emphasis upon further tourism support and development. Tourism contributed to 4.9% of GDP in 2009, attracting around 500,000 visitors. Tourist destinations include Ghana's many castles and forts, national parks, beaches, nature reserves, landscapes and World Heritage buildings and sites (Jedwab, Rémi; Moradi, Alexander 2012).

In 2011, *Forbes* magazine ranked Ghana eleventh friendliest country in the world. The assertion was based on a survey of a cross-section of travelers in 2010. Of all the countries on the African continent that were included in the survey, Ghana ranked highest.

To enter Ghana, it is necessary to have a visa authorized by the Government of Ghana, except for certain entrepreneurs on business trips.

2.3.11 Agricultural

Ghana National Agricultural Export is the government arm that operates, maintains, and oversees the planting of cocoa, cashews, and other crops for export. Since its inception, it has drastically assisted the government in boosting agricultural sales. Agribusiness accounts for a small fraction of the gross domestic product. (Data.worldbank.org.). The main harvested crops are corn, plantain, rice, millet, sorghum, cassava and yam. Unlike the agricultural livestock, forestry, and fishing sectors, the crop sector is key to the Ghanaian agricultural industry

(Data.worldbank.org.).

Table 1.3: Sector contributions to Ghana's GDP

Years	Services (%)	Industry (%)	Agriculture (%)
2006	48.8	20.8	30.4
2007	50.2	20.7	29.1
2008	48.6	20.4	31.0
2009	49.2	19	31.8
2010	51.1	19.1	29.8
2011	49.1	25.6	25.3
2012	49.1	28	22.9
2013	49.8	27.8	22.4
2014	51.9	26.6	21.5
2015	54.6	25.1	20.3
2016	56.9	24.2	18.9

Source: Ghana Statistical Service/ (Data.worldbank.org.).

The 3rd chapter

Econometric modeling and forecasting of Ghana economic growth

3.1 Panel Data set of the Ghana economic growth.

I have built my analysis on time-series data from Ghana's GDP. Most of the data was derived from the electronic Databank of World Bank specifically AND THE Ghana Statistical service. I used some of the World Development Indicators (databank.worldbank.org).

Data have been collected during the period of 2006-2016 from the main contributors of Ghana's GDP: Services, Industry, Agricultural, Services and Net Indirect Tax.). The data is annual, providing a total of 11 observations per sector for each variable. The figures I have used are the following: in the regression analysis the dependent variable is GDP growth in terms of annual values in Ghana Currency (GhȻ) in million and the right hand-side variables are Services, Industry, Agricultural, Services and Net Indirect Tax.

There are two types of analysis I have used .These are simple regression analysis and multiple regression. I used a basic linear model, where GDP growth is expressed as a function of other variables.

The general equation is the following:

$Y= \alpha + \beta 1X1 + \beta 2X2 + \beta nXn + \varepsilon$

where:

Y = dependent variable

α = constant term

β = coefficient

X = dependent or explanatory variable

n = number of variables

ε = error term (it reflects to other factors that influence Y)

SECTOR CONTRIBUTIONS TO GDP IN GHANA CURRENCY (GH₵MILLIONS)

Years	GDP	Services	Industry	Agriculture	Indirect Tax
	Y	X1	x2	x3	x4
2006	18705	8690	3704	5415	1302
2007	23154	10922	4513	6320	1902
2008	30179	13935	5855	8875	2204
209	36598	17543	6776	11343	2128
2010	46042	22184	8294	12910	4166
2011	59816	27423	14274	14155	5422
2012	75315	35837	20438	16668	4689
2013	93415.9	44964	25113	20232	6026
2014	113343	56248	28765	23640	9404
2015	136957	70159	32294	26133	13836
2016	167315	88946	37927	29565	17593

Table 4: The multiple Regression of Economic Growth in Ghana

	Coefficients	*Standard Error*	*t Stat*

Intercept	629.1504554	425.5726	1.478362
X Variable 1	0.900145397	0.06426	14.00796
X Variable 2	1.050815972	0.069195	15.18626
X Variable 3	0.959529629	0.082839	11.5831
X Variable 4	1.03431246	0.163643	6.320546

3.1.2 Interpretation of the results

The coefficient of the services sector is positive. It is statistically significant at 1 percent significance level. Specifically, a one million Ghana Cedis (GhȻ) increase in services output will cause real GDP per capita to increase by 0.090 million Ghana Cedis plus 629 Ghana Cedis million approximately, ceteris paribus. It can be inferred that services has a positive impact on real GDP per capita in Ghana, in general. This means that in the long run, increases in the output in the services sector is vital to economic growth in Ghana.

Truly, this study has found that there is a positive relationship between the output in the industrial sector and economic growth in Ghana with its statistically significant at the 5 percent significance level. Specifically, a one million Ghana Cedis increase in the industrial sector will cause real GDP per capita to increase by 1.050 million Ghana Cedis plus 629 Ghana Cedis million approximately, all other things being equal.

It was also found that the coefficient of the agricultural sector has a positive impact on growth. It is statistically significant at 8 percent significance level. A one million Ghana cedis increase in agricultural sector will lead to a rise in real GDP Per Capita by 0.95 million plus 629 million Ghana cedis approximately, all other things remaining the same.

The coefficient of indirect tax is positively signed and is statistically significant at 5 percent significance level. A one million increase in indirect tax will cause real GDP Per Capita to increase by 1.034 million Ghana cedis, all other things remaining the same.

This result obtained means that government has been spending more on the major three sectors of the economy (services, industry, and agricultural). From the long-run estimated result, these sectors serve as the major macroeconomic determinants of economic growth in Ghana including net indirect tax.

3.2 Algorithms of Ghana's Economic growth econometric modeling.

Each of the sectors of the economy has been anlysed using simple liner regression anlysis model.

The general equation for the model is the following:

$Y= \alpha + \beta 1X1 + \beta 2X2 + \beta nXn + \varepsilon$

Where:

Y = dependent variable

α = constant term

β = coefficient

X = dependent or explanatory variable

n = number of variables

ε = error term (it reflects to other factors that influence Y)

Table 3: SECTOR CONTRIBUTIONS TO GDP IN GHANA CURRENCY (GH₵MILLIONS)

Years	GDP	Services	Industry	Agriculture	Indirect Tax
	Y	X1	x2	x3	x4
2006	18705	8690	3704	5415	1302
2007	23154	10922	4513	6320	1902
2008	30179	13935	5855	8875	2204
209	36598	17543	6776	11343	2128
2010	46042	22184	8294	12910	4166
2011	59816	27423	14274	14155	5422
2012	75315	35837	20438	16668	4689
2013	93415.9	44964	25113	20232	6026
2014	113343	56248	28765	23640	9404
2015	136957	70159	32294	26133	13836
2016	167315	88946	37927	29565	17593

Table 4: Simple Linear Regression Model for the Services Sector

Regression Statistics	
Multiple R	0.998345
R Square	0.996693
Adjusted R Square	0.996325
Standard Error	3002.199
Observations	11

This means that there is a significant positive correlation between Ghana's GDP and the contributions from the services sector. The Economic growth of Ghana depends on the output in the services sector. The Multiple R is 0.998 showing a very strong positive correlation.

Figure 1.1 Line of Best Fit for the service sector and GDP

Figure 1.1 identifies trends occurring within the dataset. This form of analysis was

used to observe whether the chosen variables (GDP and services) are dependent in nature. It could be seen that the GDP of Ghana depends on the output in the service sector.

The least squares method looks to limit the deviations within a dataset when the line of best fit between the two variables is created.
In conclusion, the line of best fit above demonstrates that there are observed trends between the variables and this can be used to predict future outcomes of the economic growth of Ghana with the equation **y = 0.530x - 2549.**

Table 5: Simple Linear Regression Model for the Industry Sector

Regression Statistics	
Multiple R	0.989206
R Square	0.978529
Adjusted R Square	0.976143
Standard Error	7649.374
Observations	11

This means that there is a significant positive correlation between Ghana's GDP and the contributions from the industrial sector. The Economic growth of Ghana depends on the output in the industrial sector. The Multiple R is 0.989 showing a very strong positive correlation.

Figure 1.2 Line of Best Fit for the industrial sector and GDP

It could be seen that the GDP of Ghana depends on the output in the industrial sector. In conclusion, the line of best fit above demonstrates that there are observed trends between the variables and this can be used to predict future outcomes of the economic growth of Ghana with the equation **y = 0.0247x - 915. 2**

Table 6: Linear Regression Model for the Agriculture Sector

Regression Statistics	
Multiple R	0.9890942
R Square	0.9783074
Adjusted R Square	0.9758971
Standard Error	7688.7649
Observations	11

This means that there is a significant positive correlation between Ghana's GDP and the contributions from the agricultural sector. The Economic growth of Ghana depends on the output in the agricultural sector. The Multiple R is 0.989 showing a very strong positive correlation.

Figure 1.3 Line of Best Fit for the Agricultural sector and GDP

The line of best fit above to demonstrates that there are observed trends between the variables (GDP and Agriculture sector). They highly depends on each other and this can be used to predict future outcomes of the economic growth of Ghana with the equation **y = 0.161x+4169.**

Table 7: Linear Regression Model for the Net Indirect tax

Regression Statistics	
Multiple R	0.972254544

R Square	0.945278899
Adjusted R Square	0.939198777
Standard Error	12211.75941
Observations	11

This means that there is a significant positive correlation between Ghana's GDP and the contributions from indirect tax. Thus, the Economic growth of Ghana depends on the proceeds from indirect tax. The Multiple R is 0.972 showing a very strong positive correlation.

Figure 1.4 Line of Best Fit indirect tax and GDP

The line of best fit above to demonstrates that there are observed trends between the variables (GDP and Indirect tax). They highly depends on each other and this can be used to predict future outcomes of the economic growth of Ghana with the equation **y = 0.104x-1325.**

3.3 Forecasting of Ghana's Economic growth.

Predicting the output of each of the variables to Ghana's economic growth in the next five (5) years

	Coefficients	*Standard Error*	*t Stat*
Intercept	629.1504554	425.5726	1.478362
X Variable 1	0.900145397	0.06426	14.00796
X Variable 2	1.050815972	0.069195	15.18626
X Variable 3	0.959529629	0.082839	11.5831
X Variable 4	1.03431246	0.163643	6.320546

Services x1

Y= 629.15+0.900X

Y= 629.15+0.900*5

Y= 633.65

Industry x2

Y= 629.15+1.050X

Y= 629.15+1.050*5

Y= 634.4

Agriculture

Y= 629.15+0.959X

Y= 629.15+0.959*5

Y= 633.94

Indirect Tax

Y= 629.15+1.0343X

Y= 629.15+1.0343*5

Y= 634.32

4. Conclusions

The problem of this study was to ascertain the key macroeconomic factors that would drive Ghana's real per capita GDP growth and to determine which ways these determinants significantly influence Ghana's economic growth. In this regard, the main objective of the study is to examine the major macroeconomic factors of real GDP per capita growth in Ghana for the period 2006 to 2016 by means of multiple regression analysis using yearly data for the period and then recommend actions that should be taken to speed up the growth process in Ghana. The study shows that long-run economic growth in Ghana is largely explained by the outputs in the services, industrial and agricultural sector. Net indirect tax also has influence

on economic growth of Ghana.

It is recommended government must reform the tax system and also improve its budget balance in all the sectors of the economy. Government should continue to direct foreign assistance into its programmes to improve the productivity of each of these sectors because there was a positive strong correlation in each of these sectors to growth in Ghana's economy.

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